



United States Department of the Interior

FISH AND WILDLIFE SERVICE

P.O. Box 1306
Albuquerque, New Mexico 87103



In Reply Refer To:

AESO/ES

2-21-98-F-266

October 27, 1999

Michael W. Boardman, Colonel, U.S. Army
Garrison Commander, U.S. Army Garrison
U.S. Army Intelligence Center and Fort Huachuca
Fort Huachuca, Arizona

Dear Colonel Boardman:

This biological opinion responds to your request for consultation with the U.S. Fish and Wildlife Service pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544), as amended (Act). Your request for formal consultation was dated March 30, 1998, and received by us on April 1, 1998. By mutual written agreement, the consultation period was extended to October 29, 1999. At issue are impacts that may result from activities authorized, carried out, or funded by the Department of the Army at and near Fort Huachuca (Fort), Arizona. These impacts may affect the following listed species: Huachuca water umbel, *Lilaeopsis schaffneriana* var. *recurva*; southwestern willow flycatcher, *Empidonax traillii extimus*; Mexican spotted owl, *Strix occidentalis lucida*; lesser long-nosed bat, *Leptonycteris curasoae yerbabuenae*; Sonora tiger salamander, *Ambystoma tigrinum stebbinsi*; and critical habitat designated for the southwestern willow flycatcher and the Huachuca water umbel. Your March 30, 1998, letter also requested consultation on the American peregrine falcon, *Falco peregrinus anatum*. The peregrine falcon was recently delisted (U.S. Fish and Wildlife Service 1999a), removing the section 7 consultation requirement. Although not considered in this opinion, the Service appreciates Fort Huachuca's continuing commitment to the conservation of this species, as demonstrated by planned conservation measures outlined in Appendix 1. Through a phone call between Jim Hessil of your staff and Jim Rorabaugh of my staff on April 1, 1998, the Fort also requested conferencing on Chiricahua dock, *Rumex orthoneurus*, proposed as threatened. The proposal to list the Chiricahua dock was withdrawn during the consultation (U.S. Fish and Wildlife Service 1999b); thus conferencing is no longer needed, and Chiricahua dock is not further addressed herein.

The Fort requested concurrence from the Service that the proposed action may affect, but is not likely to adversely affect, spikedace, *Meda fulgida*; loach minnow, *Tiaroga cobitis*; and Canelo Hills ladies' tresses, *Spiranthes delitescens*. The Service concurs with the Fort's determinations for these species. Rationale for our concurrences is detailed in the "CONCURRENCES" section. The Fort also requested concurrence on determinations that the action would not affect several other species. Service policy is that we do not comment on agency "no effect" determinations

unless we believe the action would adversely affect a listed species or its critical habitat, in which case the Service would request that the agency enter into formal consultation on species adversely affected [50 CFR 402.14(a)]. Information available to us does not warrant such a request in this instance. However, we recommend that the Fort maintain a complete administrative record documenting the decision process and supporting information for "no effect" determinations.

This biological opinion was prepared using information from the following sources: your March 30, 1998, request for consultation; the March 1998 biological assessment for the project [Science Applications International Corporation (SAIC) 1998a]; a Memorandum of Agreement between the Service and the Fort, numerous hydrological studies, discussion and correspondence with the United States Geological Survey (USGS); and our files. Literature cited in this biological opinion is not a complete bibliography of all literature available on the affected species, nor is it a complete review of the effects of military activities on these species. A complete administrative record of this consultation is on file in our office.

The Service finds that activities proposed by the Department of the Army at and near Fort Huachuca over the next 10 years are not likely to jeopardize the continued existence of the Huachuca water umbel, southwestern willow flycatcher, Mexican spotted owl, lesser long-nosed bat, or Sonora tiger salamander, and are not likely to result in adverse modification or destruction of critical habitat designated for the flycatcher and Huachuca water umbel. Incidental take statements are provided for all animal species except the southwestern willow flycatcher. Note that this opinion is intended to provide comprehensive compliance with section 7 of the Act for most or all Army activities at and near Fort Huachuca. However, aspects of the Fort's activities not described in the "Description of the Proposed Action" and not evaluated in the "Effects of the Proposed Action" herein are not covered by this opinion.

Because of the length and complexity of this opinion, a Table of Contents is included on the following pages. A summary of the biological opinion appears as Appendix 2.

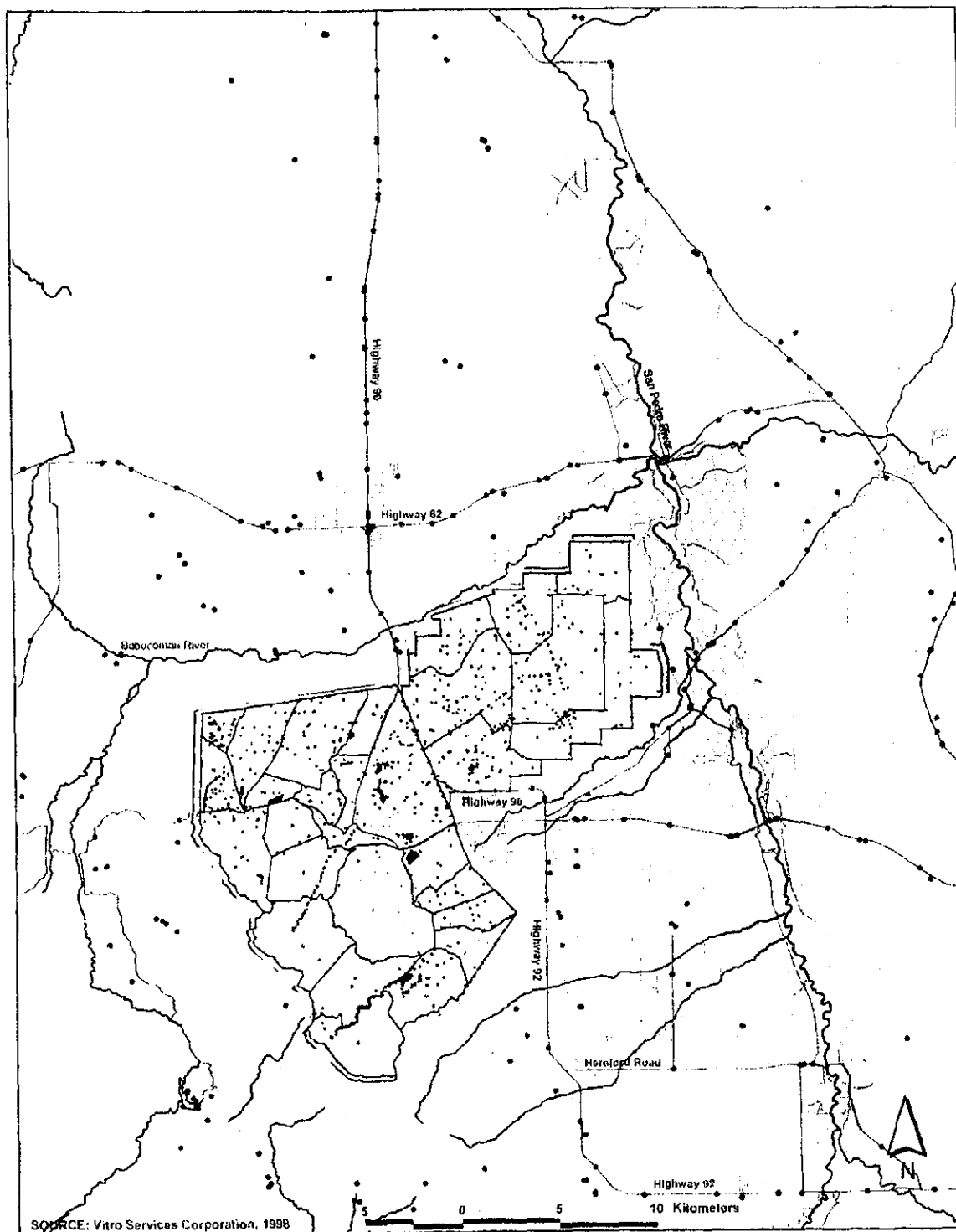
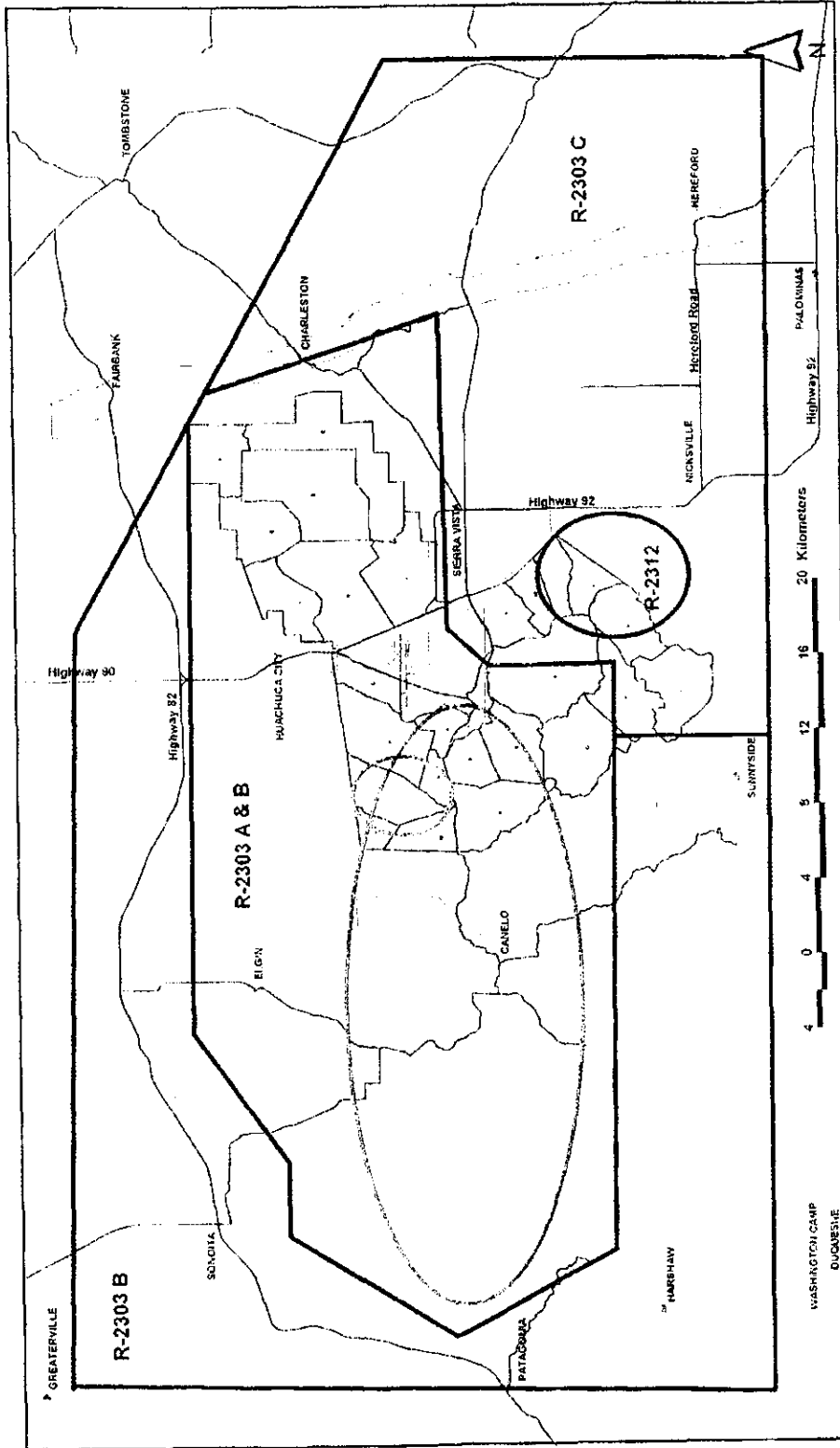


Figure 2: ASA sites on and off of Fort Huachuca

□ Fort Huachuca
 • ASA Sites
 San Pedro Riparian NCA



- Residential Air Space
- UAV Flight Area
- Training Area
- Military Area
- Noise Sensitive Area

Figure 3: Airspace and flight areas at and near Fort Huachuca. Airspace R-2312 is designated for the aerostat facility.

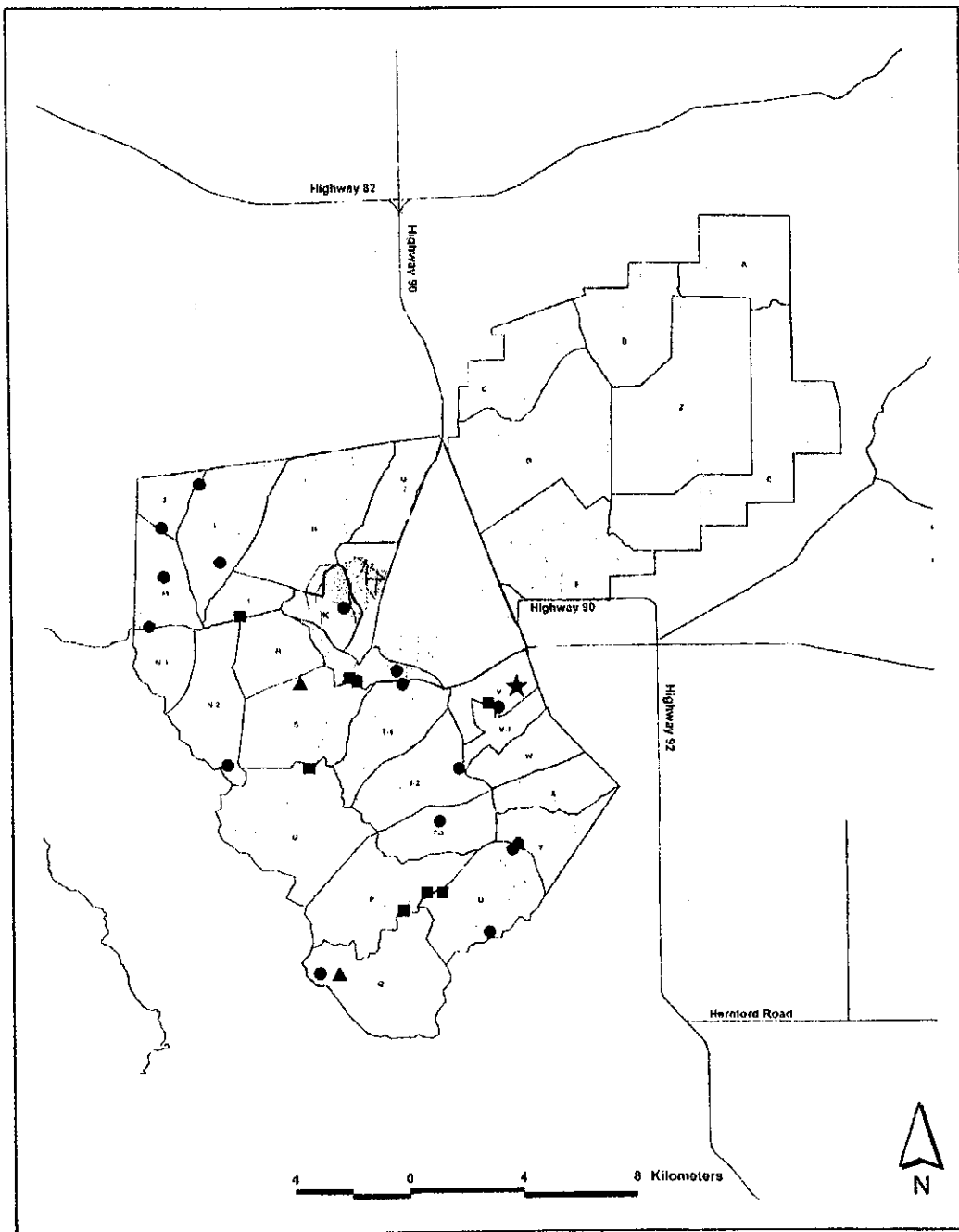


Figure 5: Ponds, game management areas, horse pastures (Buffalo Corral), and other features.

- | | | | | | | |
|-----------------------|------|-------|-------------|-------------|-------|----------------|
| Game Management Areas | Pond | Cabin | Picnic Area | Golf Course | Roads | Buffalo Corral |
| | | | | | | A |
| | | | | | | B |
| | | | | | | C1 |
| | | | | | | C2 |

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CONSULTATION HISTORY

Previous Consultations and Relationship to this Biological Opinion:

The lesser long-nosed bat, listed in 1988, was the first listed species known to commonly occur at Fort Huachuca. Listing of the bat generated a need for section 7 consultation. Since that listing, the Service and the Army have conducted section 7 consultation on numerous projects at Fort Huachuca (Table 1). Consultations are listed chronologically, from most recent to oldest, and only documents issued by the Service are described. All but one of these consultations were informal. The single formal consultation was completed January 18, 1991, with the issuance by the Service of a non-jeopardy biological opinion on the effects of proposed prescribed fire on the lesser long-nosed bat on the South Range of Fort Huachuca (Table 1).

From 1988-1993, consultation on listed/proposed species was often combined with review of National Environmental Policy Act (NEPA) compliance documents. Since 1993, consultations have often taken the form of concurrences by the Service on determinations by the Army that their activities would not effect, or would not adversely affect listed species. As more species were listed in the area (Mexican spotted owl - 1993; southwestern willow flycatcher - 1995; Huachuca water umbel, Sonora tiger salamander, and Canelo Hills ladies'-tresses - 1997), the need for consultation grew. The need for a programmatic consultation on all military activities authorized by Fort Huachuca was recognized as early as mid-1989 (see the Service's July 13, 1989, letter to the Fort - Table 1); however, as consultation workloads increased, this need became greater and more clear. Work began on development of a programmatic biological assessment in 1995. This process culminated in a draft programmatic biological assessment in August 1997 and a final document (SAIC 1998a) in March 1998.

The Service, in a letter dated May 12, 1998, informed the Fort that all materials needed to initiate consultation had been received and that formal consultation had been initiated with receipt of the Fort's request for consultation, dated March 30, 1998. The letter also indicated that a biological opinion was due to Fort Huachuca by August 13, 1998. Extensive coordination between our offices occurred during the consultation process, including frequent telephone conversations and exchange of electronic mail, including exchange of portions of the draft biological opinion for informal review and comment. Coordination meetings were held at Fort Huachuca on June 29, July 15, 1998, and April 23, 1999, among Fish and Wildlife Service and Army staff. Beverly Ohline of the Department of Interior's Regional Solicitor's Office in Albuquerque also attended the July 15 meeting. A Memorandum of Agreement (MOA) was drafted at the April 23, 1999, coordination meeting (Appendix 1.) This MOA committed the Army to developing and implementing an Army Water Resources Management Plan, working with others in the Sierra Vista area on development and implementation of a regional water resources management plan, and to implement comprehensive mitigation measures for all listed species addressed in formal consultation herein. The consultation was extended by mutual agreement to October 29, 1999. An electronic early draft of the

Table 1: Previous consultations on Army activities at or near Fort Huachuca

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-98-I-310	16 June 1998	Fire management activities South Range	Lesser long-nosed bat	The Service concurred that proposed actions may affect, but are not likely to adversely affect the bat
2-21-96-I-147	8 Jan 1998	Programmatic - all activities	Mexican spotted owl, peregrine falcon, southwestern willow flycatcher, lesser long-nosed bat, Sonora tiger salamander, Huachuca water umbel, Canelo Hills ladies'-tresses	The Service requested that the Army request initiation of formal consultation
2-21-96-I-147	8 Oct 1997	Programmatic - all activities	Same as above	The Service provided comments to the Fort on the draft Biological assessment
2-21-96-I-127	18 Aug 1997	AZ Army National Guard activities at Fort Huachuca	same as above plus jaguar, ocelot, jaguarundi, Mexican gray wolf, cactus ferruginous pygmy-owl	The Service provided comments to the Guard on the Dec 1996 draft biological assessment on Guard activities
No number	14 Jul 1997	AZ Army National Guard activities at Fort Huachuca	not specified	The Service requested environmental assessment and mitigation of Guard activities at Fort Huachuca and elsewhere
2-21-96-I-127	no date	AZ Army National Guard Activities at Fort Huachuca	Mexican spotted owl, peregrine falcon, southwestern willow flycatcher, lesser long-nosed bat, Sonora tiger salamander, Huachuca water umbel, Canelo Hills ladies'-tresses Cactus ferruginous pygmy-owl, spikedeace, and others	The Service provided comments on the 22 July 1996 draft biological assessment on Guard activities
2-21-96-I-127	9 Jun 1997	AZ Army National Guard activities at Fort Huachuca	not specified	The Service requested an update on consultation scheduling
2-21-97-I-196	4 Feb 1997	Regionalization of civilian personnel administrative functions	Mexican spotted owl, peregrine falcon, southwestern willow flycatcher cactus ferruginous pygmy-owl, bald eagle, lesser long-nosed bat, spikedeace, Sonora tiger salamander, Huachuca water umbel, Canelo Hills ladies'-tresses, Mexican gray wolf, ocelot, jaguarundi, jaguar, Gila topminnow	The Service agreed with no effect determinations for subject species
2-21-96-I-147	18 Jun 1996	preliminary draft Master Plan EIS	same as above plus Chiricahua dock	The Service provided comments on the preliminary draft EIS

Table 1 continued Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-96-I-142	13 Feb 1996	J-STARS EA	Mexican spotted owl, Huachuca water umbel Sonora tiger salamander	The Service did not concur with the Fort's finding that the Proposed action would not affect listed species.
2-21-94-I-473	22 Sep 1995	Programmatic consultation on the draft Master Plan EIS	Huachuca water umbel, San Pedro species	The Service suggested measures for mitigating possible adverse effects to San Pedro species
2-21-94-I-473	21 Jun 1995	Endangered species issues at the Fort	Southwestern willow flycatcher, Huachuca water Umbel, spikedace, loach minnow, razorback sucker, Desert pupfish, lesser long-nosed bat, Mexican spotted owl, peregrine falcon	Service comments on endangered species, especially in regard to the San Pedro River
2-21-95-I-087	21 Dec 1994	Sensitive species management Plan for the Fort	Aplomado falcon, San Pedro species	The Service forwarded a species list to the Fort and commented on concerns in regards to listed species
2-21-94-I-609	13 Oct 1994	EA for M1 tank operation	Mexican spotted owl	The Service commented on draft EA
2-21-94-I-473	14 Sep 1994	Possible base realignment	All listed species in the area	The Service provided the Fort's consultant with a species list for Fort Huachuca and surrounding areas
2-21-94-I-473	22 Aug 1994	Possible base realignment	All listed species in the area	The Service provided the Fort's consultant with a species List for Fort Huachuca and the surrounding area
no number	25 Feb 1994	8 th of the 40 th tank training	Lesser long-nosed bat	The Service conditionally concurred with the Fort's no effect determination on the bat
2-21-92-I-146	4 Jan 1994	Proposed gas station and mini-mall	none	The Service determined that no listed species were present in the project area
no number	28 Dec 1993	M1 tank maneuvers/firing	Mexican spotted owl	The Service expressed concerns over possible adverse effects to spotted owls
no number	17 Dec 1993	draft EA M1 tank operations	Mexican spotted owl, lesser long-nosed bat	The Service commented on the draft EA
2-21-94-I-054	3 Dec 1993	EA for renovation of Greeley Hall	none	The Service concurred with a no effect determination to listed species
no number	7 May 1993	EA for restricted airspace over South Range	Lesser long-nosed bat, Mexican spotted owl	The Service found that no additional effects to listed species would occur as a result of the action

Table 1 continued		Correspondence		Project	Species Addressed	Findings
Consultation #	Date of					
no number	1 April 1993			EA for comprehensive unmanned air vehicle (UAV)	Lesser long-nosed bat, Mexican spotted owl	The Service provided comments on the draft EA
no number	4 Nov 1992			EA for Applied Instructional Building for UAVs	not specified	The Service provided comments on the draft EA
2-21-92-I-742	2 Oct 1992			EA for renewal of leases at Willcox Playa and Sands Ranch	Lesser long-nosed bat	The Service concurred on the Fort's determination of no effect to the lesser long-nosed bat
no number	24 Aug 1992			EA for Applied Instructional Building for UAVs	not specified	The Service provided comments on the draft EA
no number	11 Aug 1992			Comprehensive EIS on Fort Huachuca activities and missions	Lesser long-nosed bat, Mexican spotted owl	The Service commented on the need for a comprehensive EIS and biological assessment
no number	2 Jun 1992			EA for Fort Huachuca Installation Asbestos Management Plan	Lesser long-nosed bat	The Service concurred with the Fort's determination of No effect to the lesser long-nosed bat
no number	14 Apr 1992			EA for 79 Army Security Agency (ASA) points near and on the Fort	Lesser long-nosed bat	The Service provided comments on the draft EA
no number	19 March 1992			Draft FONSI for Vehicle Magnetic Signature Dupicator test	none specified	The Service found that no listed species would be affected
2-21-92-I-153	12 March 1992			EA for Test and Experimental Command (TEXCOM), Unmanned Air Vehicle-Short Range (UAV-SR)	Lesser long-nosed bat	The Service provided comments on the draft EA
2-21-90-I-257	10 March 1992			Request to extend the UAV-SR Program to June 30, 1992	Lesser long-nosed bat	The Service provided no objection to the time extension
no number	26 Feb 1992			EA for continuation of Joint Terminal Information Distribution System (JTIDS)	none specified	The Service provided comments on the draft EA
no number	11 Feb 1992			Advanced Airlift Tactics Training Center (AATTC)	Lesser long-nosed bat	The Service provided comments on mitigation measures
no number	17 Dec 1991			Dec 1991 and Jan 1992 test of the JTIDS	none specified	The Service found that no listed or proposed species would be affected

Table 1 continued

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-92-I-193	7 Jan 1992	Proposed expansion of Black Tower UAV compound	none specified	The Service provided comments on the project
2-21-92-I-146	12 Dec 1991	Fort Huachuca Base Realignment	Lesser long-nosed bat, Mexican spotted owl	The Service provided a species list for BRAC 91
no number	2 Dec 1991	draft EA for Development of a Forward Operating Base for the Advanced Airlift Tactics Training Center, Joint Operations Training Site	Lesser long-nosed bat	The Service provided comments on the draft EA
no number	2 Dec 1991	draft FONSI for TEXCOM test of TOPHUNTER tactical communication Intelligence direction finding system	Lesser long-nosed bat	The Service provided comments on the draft FONSI
no number	2 Dec 1991	EA for Electronic Proving Ground JTIDS on 24 sites within 40 mi of Fort Huachuca	Lesser long-nosed bat	The Service provided comments on the draft EA
2-21-92-I-053	8 Nov 1991	UAV tests by TEXCOM	Lesser long-nosed bat, peregrine falcon, gila topminnow, Mexican spotted owl	The Service provided a species list for the subject project
2-21-91-I-534 2-21-91-I-442	2 Oct 1991	Exercises of the 1 st Signal Brigade	none specified	The Service found that consultation on individual exercises is not necessary under specified conditions
no number	23 Sep 1991	EA for Fire Department Training Academy	Lesser long-nosed bat	The Service found that the action would not affect the lesser long-nosed bat
no number	23 Sep 1991	UAV projects	Lesser long-nosed bat	The Service commented on the need for a comprehensive assessment of effects
2-21-91-I-534	20 Sep 1991	EA for 11 th Signal Brigade Exercises, Nov 1991	none specified	The Service concurred with the Fort's determination of no effect to listed or proposed species
2-21-90-I-257	6 Sep 1991	UAVs	Lesser long-nosed bat	The Service conditionally concurred with the Fort's determination that the project would not likely adversely affect the lesser long-nosed bat
2-21-91-I-477	27 Aug 1991	EAs for renewal of leases at Willcox Playa and near Gila Bend	Whooping crane, Tumamoc globeberry, lesser long-nosed bat	The Service concurred with the Fort's determination of no effect to listed species

Table 1 continued

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
no number	9 July 1991	8 th of the 40 th Army Reserve Unit Training, fires in agave areas, etc	Lesser long-nosed bat	The Service commented on issues involving listed species and discussed the need for a comprehensive consultation on all activities at the Fort
no number	1991	8 th of the 40 th Army Reserve activities	none specified	Compliance of the 8 th of the 40 th with conditions/environmental regulations
2-21-90-I-257	30 May 1991	UAV activities over Canelo Hills And Patagonia Mountains	lesser long-nosed bat	The Service conditionally concurred with the Fort's determination that the project would not effect the lesser Long-nosed bat
2-21-91-I-207	19 March 1991	Prescribed fire on Area W	lesser long-nosed bat	The Service provided comments on the proposed fire and identified a need for a comprehensive Fire Management plan
2-21-91-F-083	18 Jan 1991	Prescribed fire and fire breaks on South Range	lesser long-nosed bat	Biological opinion, in which the Service found that the action would not jeopardize the continued existence of the lesser long-nosed bat
2-21-91-F-083	18 Dec 1990	Prescribed fire and fire breaks on South Range	none specified	The Service acknowledged receipt of request for formal consultation
2-21-91-I-041	14 Nov 1990	Tank firing at Fort Huachuca	Lesser long-nosed bat, peregrine falcon	The Service provided a list of species in the project area
no number	4 Jun 1990	EA for UAV runway	lesser long-nosed bat	The Service concurred with the Fort's determination that The project would not affect the lesser long-nosed bat
no number	23 May 1990	Base realignment	lesser long-nosed bat	The Service concurred with the Fort's determination that the project would not affect the lesser long-nosed bat
no number	27 Mar 1990	UAV runway	lesser long-nosed bat	The Service provided comments on the first draft of the EA
no number	20 Mar 1990	NEPA, ESA issues, prescribed fire	lesser long-nosed bat	The Service provided comments on the NEPA and ESA processes
no number	21 Dec 1989	EA/scoping letter for High Frequency Test Facility at Site Sibil	lesser long-nosed bat	The Service provided comments on the draft EA/scoping letter

no number	11 Sep 1989	Relocation of High Frequency Radio Transmitter from Blacktail Canyon to Site Sybil	peregrine falcon, lesser long-nosed bat	The Service requested an opportunity to comment on the Draft EA
no number	24 Sep 1989	EA for High Frequency Test Facility	lesser long-nosed bat	The Service provided comments on the draft EA
no number	15 Mar 1990	EA for Base Realignment	lesser long-nosed bat	The Service commented on the draft EA and stated that Section 7 consultation may be required
no number	29 Aug 1989	EA for UAV	none specified	The Service concurred with the Fort's FONSI
no number	13 Jul 1989	Effects of fire and training on lesser long-nosed bat	lesser long-nosed bat	The Service commented on recent fires, and the need for a comprehensive evaluation of effects of military activities at Fort Huachuca on the lesser long-nosed bat
no number	23 Nov 1988	NEPA and ESA processes	lesser long-nosed bat	The Service identified a need for better coordination between the Fort and the Service on NEPA and ESA issues

biological opinion was sent from our Phoenix, Arizona office to Fort Huachuca in August 1998. Comments on the early draft were received from Fort Huachuca in a letter dated October 5, 1998. A second draft opinion was sent to Fort Huachuca from the Service's Region 2 Office in Albuquerque in a correspondence dated August 3, 1999. Comments on this draft were received from Fort in a letter dated September 3, 1999. This biological opinion reflects the comments of Fort Huachuca as expressed in that letter and during extensive coordination through the consultation process. The MOA was signed by the Service concurrently with this biological opinion.

BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

The action evaluated in this opinion includes ongoing and planned military operations and activities at and nearby Fort Huachuca, including the airspace currently used by the Fort, for 10 years from the date of this opinion. In addition to military training and operations, the proposed action also includes recreation and resource management, such as fire suppression and prescribed fire, public use areas and restrictions, and wildlife and fisheries management on the installation. Much of the following discussion was taken directly from SAIC (1998a).

Location and Setting

Fort Huachuca is comprised of approximately 73,272 acres located west of the San Pedro River and the City of Sierra Vista in Cochise County, southeastern Arizona, approximately 75 miles southeast of Tucson and eight miles north of the Mexican boundary. The Fort includes semi-desert grasslands and Chihuahuan desertscrub on the bajada at the base of the Huachuca Mountains, as well as the forested east slope of the Huachuca Mountains from approximately Tinker Canyon on the south to the northern end of the range.

Military Operations and Training

Fort Huachuca is divided into three training ranges (South, West, and East) and a cantonment area. Each of the three ranges are further subdivided into training areas. A total of 26 training areas occur on the three ranges (Figure 1). The operational baseline at Fort Huachuca is comprised almost entirely of intelligence and communications systems, research, development, testing, and training; these activities account for nearly 95 percent of training range use. Other military activities on the installation include field training exercises, aviation activities, small arms qualification and training, vehicle maneuver training, and administrative and support activities.

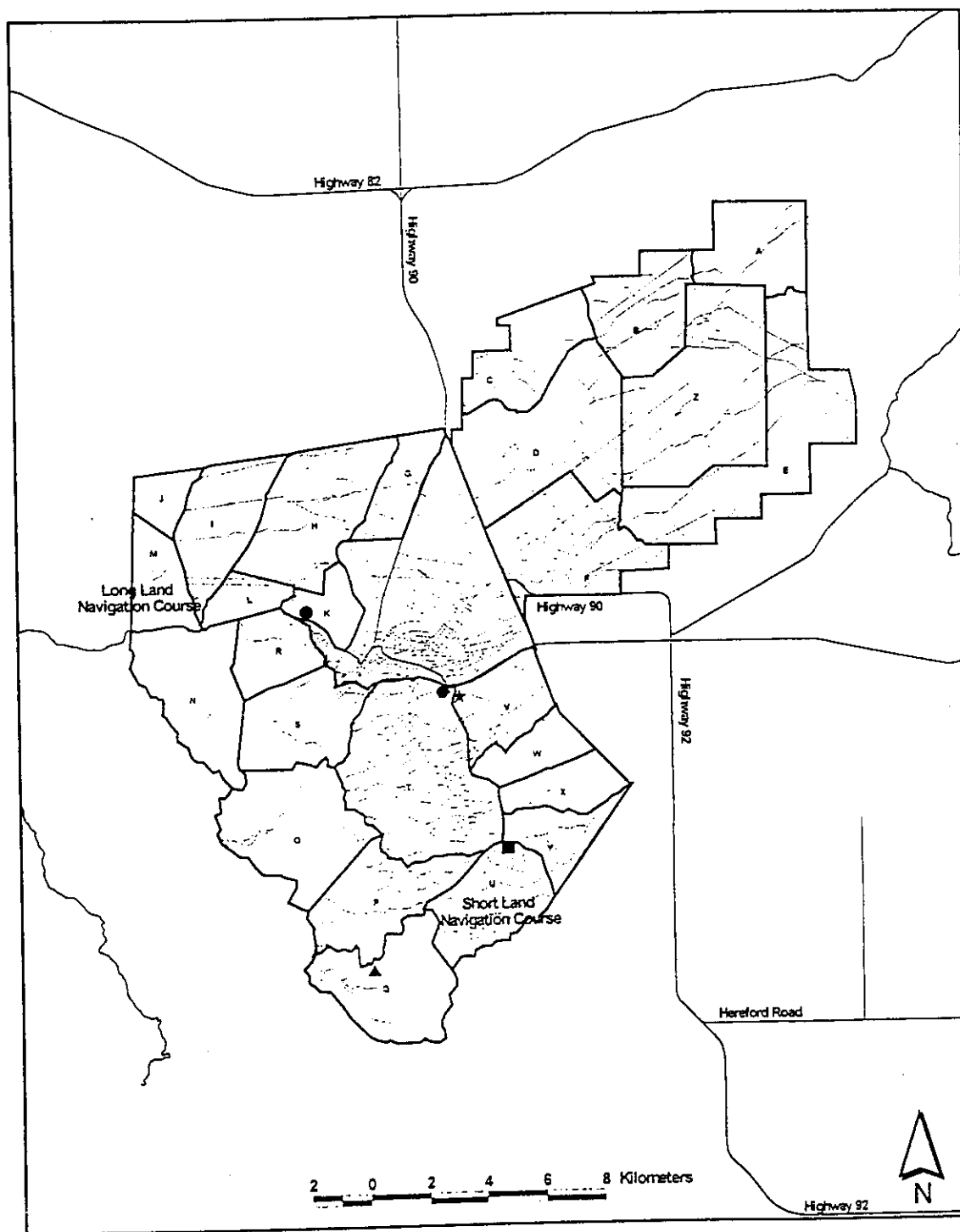


Figure 1: Training ranges A-Z, Fort Huachuca

- Facilities
- ★ C-SA Aircraft Training Mock-up
 - Demonstration Hill
 - Leadership Reaction Course
 - ▲ Rapelling Cliffs
 - Rapelling Tower
 - Training Areas

Intelligence and Communication Systems

The majority of operational testing and training at Fort Huachuca is related to intelligence and communications systems. Units are engaged in the development and testing of various types of electronic equipment (see Appendix E of SAIC 1998a for detailed descriptions of these units). These units are also involved in training soldiers in the use of this equipment in classrooms and field exercises.

Intelligence and Electronic Warfare Equipment Training and Testing

A major mission at Fort Huachuca is the testing of intelligence and electronic warfare equipment and training of soldiers on intelligence operating procedures requiring realistic placement of intelligence systems over wide areas. Equipment is stationed at various Army Security Agency (ASA) sites across the installation and off-post to test the capability of electronic systems to operate under a variety of geographic and atmospheric conditions. These sites constitute a network of approximately 2,400 on-post and 675 off-post markers (see Figure 2). Training and testing is conducted by dispatching intelligence and electronic warfare equipment to a selection of ASA sites that meet the requirements for training to be conducted. On-post sites are located across the installation along existing roads and trails and previously disturbed areas. Off-post sites are usually located within the road right-of-way shoulders along several highways in Cochise and Santa Cruz counties. The remaining off-post sites are located in previously disturbed areas.

At the time of training, vehicles and personnel can be deployed to any combination of ASA sites but most remain on Fort Huachuca. Training sites generally consist of one to two vehicles with four to six support personnel and up to approximately 20 students. On rare occasions, training activities can be as large as 20 vehicles, 50 support personnel, and 60 to 70 students. Types of equipment include electronic, computer, or radar imaging systems. The vehicular components of the intelligence training systems can consist of military five-ton trucks, heavy duty four-wheel drive vehicles, and on very infrequent occasions, tracked vehicles. These vehicles are either equipped with an electronic equipment shelter or used to transport soldier-transported systems and operators. These vehicles are driven to the site and parked in pre-determined areas while operations are underway. No off-road vehicle travel outside previously established parking areas or designated sites is authorized. Vehicles must either remain on established roads or trails or can park adjacent to the road or trail in a previously disturbed, designated area at each ASA site. Tracked vehicle movement is not authorized outside of the installation and is confined to existing roads and trails in training areas Bravo, Charlie, Delta and Foxtrot (B, C, D, and E on Figure 1) on the East Range. Tracked vehicles are sometimes used outside the installation, but on these occasions they are transported to the site on trailers.

If necessary for the test, they are off-loaded and remain stationary. During no test do they maneuver outside the installation.

Several types of transmitting antennae are used, from small vehicle or system mounted whip antennae, to ground mounted antennae that can be raised to a height of 65-80 feet. At each site, antennae(s) may be erected consisting of driving metal or wooden stakes into the ground 12-18 inches for the attachment of guywires. Most exercises last for no more than ten to eleven days with 18 daily hours of operation, but activities may last as long as 90 days. On occasion some training can require groups of students to conduct limited dismounted exercises during day/night operations. This training can require 30 to 50 students to walk cross-country to other predetermined locations or ASA sites. Training sites located in or near protected agave management areas found in training areas Lima, Mike, and portions of Hotel, India, Tango, Victor, Whiskey, X-Ray, and Yankee adhere to special use restrictions. These restrictions stipulate that:

- a. no firing of blanks or pyrotechnics will occur within 0.25 miles of protected agave management areas;
- b. training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment; and
- c. Night operations are prohibited from July 1 to October 31 in protected agave management areas.

Military trainers and civilian testers who fail to comply with these measures of protection may lose their privilege to train or test in these areas at the discretion of the Range Control Officer.

Communications Systems Training and Testing

Another major mission at Fort Huachuca involves radio systems training and testing. The physical components of the systems under training consist of a variety of satellite, troposcatter, high-frequency, and microwave equipment to provide communications support. Portable equipment is moved on military five and two ton vehicles pulling a wide variety of generators, antennae, and trailers. During training, vehicles and personnel are deployed to a variety of preexisting sites across the installation. Typical exercises last from seven to 14 days with 24 hour operations. Each field unit may utilize up to approximately 40-80 vehicles, 50 generators, 12 communications shelters, and 80 to 100 soldiers per site, but generally as little as three vehicles and nine soldiers at each relay site. The maximum area covered by a unit during training is approximately 40 acres with 13 remote site locations per exercise. Large bivouac exercises occur in predefined areas used repeatedly for such activities with relay sites located across the installation. Predefined bivouac areas often include permanent structures and concrete pads for repeated bivouac establishment. Remote relay sites are located all across the

installation. Sites selected for use across the installation must be approved by Range Control prior to use. Range Control may restrict the use of certain areas during high fire potential seasons and enforces the previously-discussed special regulations for protected agave areas (see above).

Two types of larger exercises are also conducted, including Battalion and Brigade. Battalion level exercises involve 400-500 personnel in which approximately 200 vehicles are used with 46 such exercises conducted every year. Brigade level exercises involve 1,000 to 1,200 personnel with approximately 500 to 600 vehicles used in such operations with 23 such exercises conducted each year. There are no set timelines for testing activities. Tests are conducted year-round, and might last 24 hours per day, seven days per week, for months at a time. These activities occur at similar sites to those mentioned previously for communications training. Range Control may restrict the use of certain areas during high fire potential seasons and enforces the previously-discussed special restrictions for protected agave areas.

AVIATION ACTIVITIES

Aviation activities at Fort Huachuca include fixed-wing piloted aircraft training, rotary-wing piloted aircraft training, unmanned aerial vehicle (UAV) testing and training, and unmanned drug surveillance balloon operation. Most aviation activities occur at Libby Army Airfield (LAAF), a military-civilian joint-use facility located along the northern boundary of the cantonment area. The LAAF supports military aircraft involved in test and training programs, troop movements, and standard military, commercial and private travel operations. Three runways, several taxiways, aprons, and parking areas for fixed and rotary-wing aircraft cover the largest portion of the airfield area. Air operations are sustained by numerous support facilities which include a flight control tower, a navigational aids building and airfield operations building, an airfield fire and rescue station, utilities support structures and storage buildings. Air space used by UAVs at Fort Huachuca and restricted airspace currently used by the installation is shown in Figure 3. Flight corridors and other aviation-related training areas at Fort Huachuca include:

- a C-5A aircraft training mock-up (training area Victor) - a concrete platform depicting a C-5A aircraft cargo bay used to simulate cargo loading;

- an emergency helicopter landing area (training area Victor);

- helicopter landing areas for proficiency and emergency operations (training areas November, Romeo, India, and Kilo);

the Hubbard Assault Airstrip (training areas Bravo and Delta) - a dirt assault strip/landing zone, surveyed and approved by the U.S. Air Force, which can accommodate C-130 aircraft (2,200 x 5,250 feet);

the Hubbard Drop Zone (training areas Charlie and Delta) 2,800 x 5,600 feet;

the Humor Drop Zone (training area Bravo) 2,700 x 5,450 feet;

the Havoc Drop Zone (training areas Charlie and Delta) 2,800 x 5,600 feet; and

the Hyena Drop Zone (training area Echo) 1,000 x 1,000 feet.

Approximately 70,155 aviation evolutions (each landing or departure counts as one evolution each) occurred at LAAF between September 1996 and August 1997. Military operations included approximately 50,651 evolutions or 72 percent of all activity (of these 50 percent were jet and 50 percent were propeller). General aviation accounted for approximately 11,015 evolutions or 16 percent of all activity. Commercial air traffic accounted for approximately 8,489 evolutions or 12 percent of all activity.

Approaches to LAAF are considered Class D Airspace since the facility contains a manned operating control tower. The airport's airspace includes a horizontal radius of 4.3 statute miles of the airport, extending from the surface up to 7,200 feet mean sea level. Aircraft are not permitted to enter the airspace until the Air Traffic Control tower is contacted for clearance to do so. During the time the tower is closed, the airspace reverts to Class G, or uncontrolled airspace.

Restricted areas contain airspace identified by an area on the surface of the earth within which the flight of aircraft is subject to restrictions. If the restricted area is active, the air traffic control tower having jurisdiction over the airspace needs to authorize clearances to aircraft that cannot avoid the restricted area, unless the aircraft is on a previously approved altitude reservation mission or is part of an activity within the restricted area. If the restricted area is not active and has been released to the controlling agency (FAA), the air traffic control facility will allow aircraft to transition through the airspace without issuing special clearances. Four restricted areas, R-2303A, R-2303B, R-2303C, and R-2312, are located in the vicinity of LAAF. Flight operations originating at LAAF (i.e., helicopter and unmanned aerial vehicle operations) utilize only small portions of this airspace.

Fixed-Wing Piloted Aircraft Training

No military fixed-wing piloted aircraft training activities originate at Fort Huachuca. However, Fort Huachuca authorizes use of airspace and facilities at the installation by other Department of Defense (DOD) agencies for proficiency testing and training during exercises originating at other installations. The following summary discussions represent aviation activities which utilize Fort Huachuca airspace or facilities during training or testing operations.

Individual pilot proficiency training for the U.S. Air Force and U.S. Air Force Reserve is conducted in Fort Huachuca airspace and at LAAF facilities. The most common aircraft is the ground attack A-10 aircraft flown out of Davis-Monthan Air Force Base in Tucson. These A-10s averaged 18,885 flight evolutions at LAAF for calendar years 1988-1993, for an average of 37 percent of the annual military activity at the airfield. This training consists of low altitude touch-and-goes (simulated aircraft landings and take-offs where aircraft are flown to LAAF and make approaches to the airfield, simulate a landing, and depart without actually grounding the aircraft).

The Arizona Air National Guard and Missouri Air National Guard use Fort Huachuca airspace and LAAF facilities on a continuous basis for individual proficiency training for pilots. The Arizona Guard 162nd Fighter Group, headquartered in Tucson, uses LAAF for instrument approach procedures, missed approach procedures, instrument departure procedures, and touch-and-go takeoffs and landings. Most training is conducted using the Lockheed C-130 aircraft, a four-engine turboprop powered tactical transport. Other similar turboprop transports, such as the two-engine Transall C-160, are used by some training units. Aircraft of both guard units have used LAAF for an annual average of 21,400 flight evolutions, or approximately 42 percent of the annual military activity at the airfield.

Drop zones on the East range and the Hubbard Landing Zone are used by the Arizona and Missouri Guard units as training flight destinations/objectives where actual airdrops or landings can be practiced. The Hubbard Landing Zone provides tactical airlift crews a rare peacetime opportunity to land and takeoff from a dirt runway. The Hubbard Landing Zone is presently used by each training aircrew for four landings and takeoffs during the class period. Annual operations for the landing zone are approximately 720 evolutions.

Rotary-Wing Aircraft Operation and Training

Most rotary-wing aircraft operations occur at LAAF. On occasion, rotary-wing operation may occur at the various helicopter landing pads across the installation and at the Black Tower UAV complex on the West Range. Typical rotary-wing aircraft operations originating from Fort Huachuca include departure from LAAF upwards to approximately 8,500 feet above mean sea level and subsequent cross-country travel throughout Arizona to other military installations and destinations. Rotary-wing traffic adheres to existing restricted airspace regulations. Helicopters are required under FAA regulations to be operated in a safe manner. Three helicopters are currently in operation at Fort Huachuca. They are primarily operated at 3,500 feet above ground level, but may be operated at any elevation that is safe. Joint Task Force 6 helicopters take off and land at Fort Huachuca; JTF6 pilots receive briefings on installation regulations prior to take-off. JTF6 flights occur approximately 20-25 days annually and include low-level flights along the Mexico border, but not on Fort Huachuca.

Unmanned Aerial Vehicle Testing and Training

In general, UAVs are large radio-controlled aircraft that have a 20-30 foot wingspan and are approximately 20-30 feet long. Fort Huachuca currently supports the operation of two UAV projects: Pioneer and Hunter. These UAVs have standard flight elevations of 3,500-4,000 and 6,500-7,000 feet above ground level respectively during testing and training activities. The minimum altitude at which UAVs travel (excluding take off and landing approaches) is 1,000 feet above ground level. UAVs generally operate above the West Range and to the west of Fort Huachuca (Figure 3). The UAV Training Center on the West Range provides support to the Pioneer UAV Training Site. This training is conducted at the Black Tower Complex approximately six miles west of the cantonment area on the West Range. The mission is to train UAV operators for the U.S. Army, U.S. Marines, and U.S. Navy. Operational proficiency training involves field exercise activity by the active duty operational Army units located at Fort Huachuca and the combined services UAV training. The training center operates on the West Range from approximately 5:00 AM to 4:00 PM with infrequent night operations. They use equipment such as UAVs, ground control stations, five-ton trucks, mobile power units, and antennas.

Flight tests involve take-off from the Fort Huachuca UAV complex on the West Range and travel westward to the Canelo Hills and Altar Valley target areas. Within the two target areas, accurately surveyed ground points are marked with steel reinforcing bar rods as potential target vehicle parking spots. These temporary markers are placed at each target site so vehicle drivers can locate the area. During the flight tests, five or six trucks may be positioned at fixed stations within each target area for up to four hours at a time. The target vehicles used are

generally two-ton trucks (two each), and four-wheel drive pickup trucks (eight each). No off-road travel by vehicles is authorized. Target vehicles are provided with shovels and fire extinguishers.

Other activities conducted by UAV facilities involve flight tests of UAV systems requiring moving and fixed imagery targets. The last such operation was conducted in 1992 when areas beyond the Fort boundaries were used. At present one such operation is planned for June 2000. Typically, the activity is broken into two parts:

- Launch and recovery of the vehicles from training areas India and Juliet (Hubbard and Rugge-Hamilton sites) which does not involve a large number of vehicles or personnel.

- Imagery targeting which involves the creation of imagery targets for the UAV's such as command posts, tank personnel, etc.

The activities are located across the East and West ranges at previously determined sites. The number of personnel per target positioning can range from five to a maximum of 90. Each unit spends one to two days in each area and then may be replaced by another detachment. The movement of vehicles is confined to existing roads and trails, with some occasional off-road foot traffic activity. The number of vehicles in an area at a given time is approximately 18 per exercise. Rocket-assisted takeoffs (RATOs) occur at Pioneer and Rugge-Hamilton airstrips. The noise generated by the takeoff rockets ranged from 76 to 93 dB. Due to the expense of the equipment, RATOs generally occur less than 10 times a year at the installation.

Unmanned Drug Surveillance Balloon Operation

In 1987, an AEROSTAT Drug Surveillance Balloon became operational in the southern portion of the South Range. The blimp-type balloon is ground tethered and is an aerial platform for radar equipment used to detect aircraft illegally entering the U.S. It provides radar data for U.S. Customs, the DOD, and the FAA. It operates year round, 24 hours per day, within approximately 23 acres of training area Y on the South Range. Airspace used for the AEROSTAT balloon is shown in Figure 3. This airspace is restricted only for AEROSTAT activities.

FIELD TRAINING EXERCISES

Fort Huachuca is used for training by various Fort Huachuca operational units and Fort Huachuca partner organizations. All training activities requiring use of range facilities are

scheduled, coordinated, and controlled through the Range Control. Field training exercises consist of land navigation, patrolling and tactics training, individual development training, and vehicle maneuver training.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. Specific bivouac areas vary from exercise to exercise and do not always coincide with existing ASA sites. Use of any site must be requested a minimum of 21 days in advance from Range Control.

No vegetation clearing is authorized during the establishment of a bivouac. Holes can only be dug into the ground with prior permission from Range Control. Concrete pads in some permanent bivouac areas are used for cooking purposes to prevent waste water from seeping to the ground in case of spills.

There are approximately 10 established bivouac areas on the installation. These sites are used on a more frequent basis for the larger scale communications testing and training activities. These larger bivouac areas (40 acre) are maintained as permanent areas of repeated use so as to minimize the need for additional large set up areas.

Land Navigation

Land navigation involves the training of personnel to accurately navigate the terrain on foot and locate pre-established sites and locations. Land navigation exercises typically involve approximately 15 to 20 personnel and four to five vehicles for transportation of personnel to and from the field. Operations generally last for one day from morning until evening and are conducted year round except in protected agave management areas. There is no live fire, firing of blanks, or pyrotechnics permitted. There are two existing land navigation courses on the installation:

- Land navigation course in training area Uniform consisting of 44 surveyed concrete points with ASA markers.

- Land navigation course in training area Mike consisting of 58 surveyed concrete points with ASA markers.

Additional land navigation training is conducted across the installation on the West and South Range. This training is similar to that which occurs on Land Navigation Courses. Vehicles are used to transport personnel to and from the field and are kept on existing roads, trails or

parking areas at all times. There is no live fire, firing of blanks, or pyrotechnics permitted. Activities are conducted during day and night times, except within protected agave management areas where night operations are prohibited from July 1 through October 31.

Patrolling and Tactics Training

Patrolling and tactics training occurs across the South and West ranges. The exercises, which generally last three days, are conducted every month of the year. Approximately 43 personnel are involved in the operations each month. Ammunition used during these operations include pyrotechnics, smoke, and M16A2 blanks.

In these training exercises, soldiers maneuver on trails and cross-country. They occasionally dig holes about five inches deep to bury sensors near the trails and major roads. All vehicles used during this training are kept on existing roads and trails.

Training may take place during the day or at night. No firing of blanks or pyrotechnics can occur within 0.25 mile of protected agave stands. Firing of blanks is also prohibited if it is determined by Range Control or the Fort Huachuca Fire Chief that a fire hazard exists. Activities are conducted during day and night times, except within protected agave management areas where night operations are prohibited from July 1 through October 31.

Individual Development Training

Several individual development training facilities are located on the South and West Range and within the cantonment area including:

- a rappelling tower (Training area Tango) - A two-level tower platform used for rappelling practice;

- a rappelling cliff (Training area Quebec) - Cliffs located in Garden Canyon which vary in height from approximately 70 to 100 feet;

- a rope bridge Training Site (Training area Victor) - An open area with four upright telephone pole tops, approximately four feet high;

- a Leadership Reaction Course (Training area Uniform) - Eight stations, each depicting a situation which requires the negotiation of obstacles by an expedient means; and

- a Demonstration Hill (Training area Kilo) - May be used to conduct various types of demonstrations.

These permanent facilities are used to train personnel from a variety of host and partner organizations

Vehicle Maneuver Training

Vehicle maneuver and driver training activities occur across the installation on various existing roads and trails. The majority of all vehicle maneuver training consists of wheeled-vehicles with occasional tracked-vehicle training. Wheeled-vehicle training maneuvers can include attaching and detaching trailers, loading and unloading equipment, and driver training across the installation. All maneuvering activities are confined to the existing roads and trails.

Oversized vehicles are restricted to roads; whereas light vehicles can use roads and trails. A trail is defined as a route that is maintained periodically. No cross country maneuvering or other use of existing off-road maneuvering lanes occurs or is planned during the timeline of this consultation. All existing and planned operations will adhere to the following regulations.

Follow Fort Huachuca Regulation 385-8, Safety - Range and Training Area Operations (19 October 1994);

Follow guidelines set forth in the Installation Spill Contingency Plan - Fort Huachuca, Arizona (20 December 1996); and

Submit Fort Huachuca Form 1155 (REV), 1 Aug 93 through appropriate channels for approval prior to commencement of maneuvers which require access to the East Range.

Off-road vehicle travel is not authorized at any location on Fort Huachuca. Training areas Charlie and Delta (East Range) contain the only locations where off-road vehicle use may occur at Fort Huachuca during the life of the project. These locations comprise approximately 5,172 acres designated for off-road maneuvering lanes. No off-road activity has occurred since 1994. For the purposes of this consultation, no off-road vehicle use is proposed. The Arizona Guard may propose off-road vehicle training in these designated areas. If such a proposal is made, it would be the subject of separate section 7 consultation, or as an amendment to this biological opinion.

Live Fire Qualification and Training

Most live fire activities take place on weapons qualifications ranges in training area Tango. Maximum ammunition and associated noise levels used on these ranges are listed (Table 2). Locations of these firing ranges and their associated safety fans are provided in Figure 4.

Under appropriate conditions, tracer rounds are permitted on all live firing ranges with the exception of Ranges 2, 3, and 4.

Small Arms

Small arms qualification and live fire at Fort Huachuca occur only on nine of the 17 existing live fire ranges in training area Tango. Firing ranges are used for personnel qualification and training throughout the year. Live fire does not take place at night on ranges 2, 3, and 4 during the period July 1 through October 31.

Artillery And Mortar

The East Range contains several surveyed firing points usable for mortar and artillery firing into Impact area Zulu. These points support 60 & 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. Use of areas outside of the preexisting firing points which are requested for use must be surveyed to 5th Order (1/1000) accuracy with accompanying environmental analysis prior to submission to Range Control for approval.

Training activities which include use of the East Range for mortar firing must carry sufficient fire suppression equipment at all times in the event of a fire. Range Control regulations also require observation personnel to maintain constant watch during training activities for accidental fires resulting from mortar use on the East Range.

ADMINISTRATIVE AND SUPPORT ACTIVITIES

The administrative and support activities performed at Fort Huachuca are those activities associated with the day-to-day operation of the installation and the ranges, inclusive of those activities performed by USAIC&FH, the directorates, and partner organizations. Several administrative and support organizations exist at Fort Huachuca to support the installation's ongoing role as a major Army testing and training installation. Personnel from these organizations are located in the cantonment area.

The U.S. Army Garrison at Fort Huachuca includes the Command Group; Protocol Office; Public Affairs Office; Chaplain Activities Office; Inspector General; Office of the Staff Judge Advocate; Joint Planning Group; Office of the Chief of Military Intelligence; the Directorate of Installation Support (DIS); Resource Management; Public Safety; Programs for Community Activities; Human Resources; Information Management; Contracting; Operations; Training and Doctrine; Evaluation and Standardization; and Combat Developments. The Garrison also

Table 2: Firing Range Descriptions

Range	Range Utilization	Maximum Ammo Permitted	Maximum Noise Level At Firing Point ¹
Range 1	Currently inactive	NONE	N/A
Range 2	M-16 Rifle Zero Range with 32 firing points and a target width of 100 meters.	5.56mm	156 dbP
Range 3	Small bore multi-purpose range with 16 firing points, and 75 meters maximum range.	5.56mm	156 dbP
Range 4	Pistol range complex consisting of a competition firing range with 25 firing points and target distances at 25 and 50 meters (Range 4A), and an U.S. Army Standard Pistol Qualification course consisting of four firing points with target distances from 7 to 31 meters (Range 4B).	.45 cal	162 dbP
Range 5	High explosive hand grenade range with 8 firing points.	M67 FRAG (ONLY)	171 dbP
Range 6	Fifty firing points and six firing lines from 100 to 1,000 yards.	7.62mm	159 dbP
Range 7	Currently inactive	NONE	N/A
Range 8	Automated record fire range with 10 firing points and target distances from 50 to 300 meters.	5.56mm	156 dbP
Range 9	Range 9A serves as a multi-purpose machine gun range with four firing points, Range 9B is used for recoilless rifles.	.50 cal, 90mm	160 dbP
Range 10	M-79 and M-203 grenade launcher range. High Explosive (HE) cannot be fired on this range.	40mm	154 dbP
Range 11	Currently inactive	NONE	N/A
Range 12A	.50 caliber, 7.62mm and 40mm live fire weapons range. HE ammunition cannot be fired on this range.	120mm, .50 cal	160 dbP
Range 12B	Tank gunnery range. HE ammunition cannot be fired on this range.	NONE ²	N/A
Range 12C	Tank gunnery range. HE ammunition cannot be fired on this range.	NONE ²	N/A
Range 13	M-16 marksmanship record fire range with 16 firing positions and targets from 50 to 300 meters.	5.56mm	156 dbP
Range 14	Currently inactive Squad attack course	NONE	N/A
Range 15	Currently inactive Platoon attack course	NONE	N/A

1. Based on impulse noise levels and do not represent steady noise or time-weighted average (SAIC 1998a)

2. There is no tank gunnery firing currently authorized at Fort Huachuca. Source: Zillgens 1991; SAIC 1998a

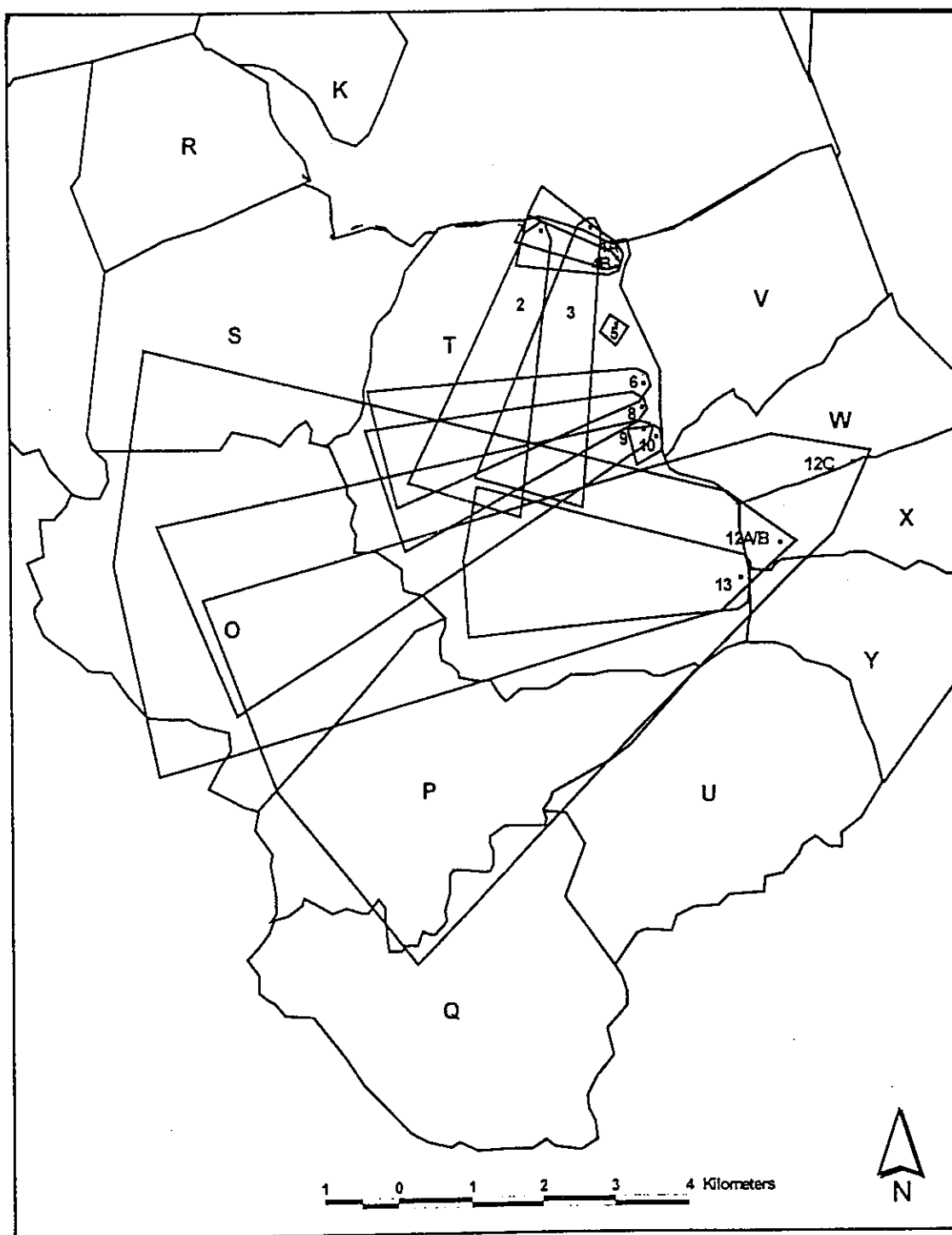


Figure 4: Live fire ranges and firing fans, South Range, Fort Huachuca. ^a₃₅

includes a Department of Tactics, and Intelligence and Military Science. These offices support more than 40 commands, agencies, and activities which reside across the installation. Each organizational element may contain additional divisions, branches, and sections. The offices and directorates are primarily located within the cantonment area.

RECREATIONAL ACTIVITIES

Southeastern Arizona is a popular destination for local visitors, as well as national and international travelers. The San Pedro Riparian National Conservation Area (RNCA), the Scenic Railroad, Coronado National Forest, Coronado National Memorial, Ramsey Canyon Preserve, and other unique tourist and recreational attractions further enhance visitor interest in the area. Current recreational use in the Sierra Vista area is most concentrated in areas just outside the Fort such as Ramsey and Carr canyons and the San Pedro RNCA (SAIC 1998a). Garden, Huachuca, and Scheelite canyons are additional popular recreational sites located within installation boundaries. In 1995, approximately 30,000 birders visited these canyons (SAIC 1998a). With the development and future opening of Karchner Caverns State Park, recreational interest throughout the area will continue to grow with an emphasis on scenic, natural and cultural resources.

Recreational Activities at Fort Huachuca

Recreational use of Fort Huachuca lands has increased in recent years along with the general increase in tourism throughout the Cochise County area. Fort Huachuca is an open post and areas outside the firing ranges and impact areas are typically available for recreational activities. The variety of natural and recreational resources in the Fort Huachuca area, especially for bird watching and hiking, suggests that interest in these resources will continue to grow. Popular activities at the Fort include bird watching, hiking, horseback riding, golfing, fishing, and hunting. Public access to recreational areas may be prohibited by the Range Control officer due to ongoing training and testing activities, or fire hazard. As a result, some or all of Fort Huachuca may be closed to recreational activities on any given day.

Hunting and Fishing

Mule deer, white-tailed deer, pronghorn, javelina, and mountain lion are historically the big game species hunted at Fort Huachuca. Hunters also have the opportunity to hunt three species of quail and two species of dove. There are 30 hunting management areas on Fort Huachuca.

Fort Huachuca hunting seasons and bag limits are set in coordination with the Arizona Game and Fish Department. Hunting regulations are provided in Appendix F of SAIC (1998a).

There are 16 ponds (approximately 32 acres) located on post. Seven of these ponds are stocked with trout if water conditions are favorable (Figure 5). Golf Course and Gravel Pit ponds may be fished 24 hours per day, year round, with the proper permits. All other ponds open to fishing, may be fished between 0500-2100 hours with some additional restrictions. Garden Canyon Creek is closed to fishing. The use of salamanders as bait is prohibited by the Arizona Game and Fish Department in Cochise County west of the San Pedro River and south of State Highway 82, including Fort Huachuca. The number of permits issued for hunting and fishing on the Fort has decreased in recent years. Typically the Sportsmen Center at Fort Huachuca issues 1,300 permits by August. In 1997 only 798 permits were issued by August. This decrease may be attributed to the drought in 1996, and thus fewer fishing permits issued (SAIC 1998a).

Hiking, Camping, and Sports

There are several camping and picnicking areas on Fort Huachuca. Figure 5 shows the location of these areas. They include:

- Lower Garden Canyon picnic area which has ten sites with tables and grills and is open to self-contained recreation vehicle and tent camping. The area includes a comfort station, playgrounds, and a ramada for protection from the sun and rain.

- Middle Garden Canyon picnic area which has picnic tables, grills, a playground, and ramada.

- Upper Garden Canyon picnic area which has picnic tables, grills, a playground, and ramada.

- Golf Course Pond which has 12 picnicking sites with tables, grills, and ramadas. RV camping is permitted and a comfort station and softball field are located on site.

- Apache Flats Recreational Vehicle (RV) Park which has 50 spaces for RVs with electricity, picnic tables, grills, tenting spaces, and a dump station. Water is available at 50 spaces.

- Split Rock cabin.

- Garden Canyon cabin.

- Sportsman Center campground which has 24 hookups for RVs, ramadas, picnic tables, and grills.

Garden and Huachuca canyon areas offer wooded sites for picnicking away from the main post. Reservoir Hill offers a spectacular view of much of the San Pedro Valley. The golf

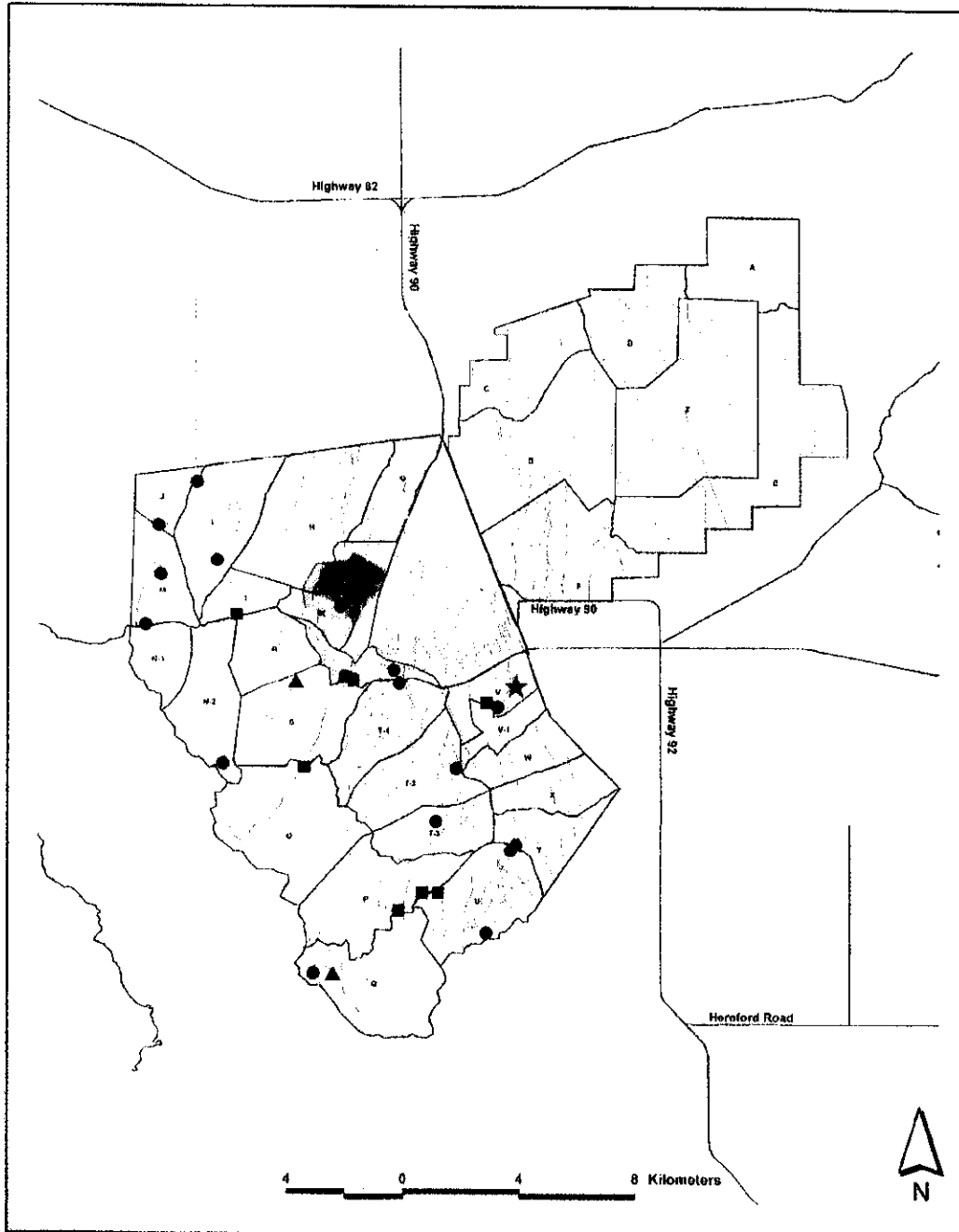


Figure 5: Ponds, game management areas, horse pastures (Buffalo Corral), and other features.

- | | |
|-----------------------|----------------|
| Game Management Areas | Buffalo Corral |
| Cabin | A |
| Pond | B |
| Picnic Area | C1 |
| Golf Course | C2 |
| Roads | |

course pond area provides a variety of recreational opportunities. Camping on post is permitted only in designated campgrounds and mountain areas are accessible only during the day. Approximately 45 miles of hiking trails are available on the Fort. Some of these connect with trails on the Coronado National Forest and provide hiking access to other portions of the Huachuca Mountains including the Miller Peak Wilderness Area.

Recreational rock climbing and rapelling is prohibited. An existing 18-hole Fort Huachuca golf course serves both military and civilian personnel and is located on the eastern end of the cantonment area just south of the Main Gate to the post. Caving is permitted during certain times of the year. This activity is restricted during times of lesser long-nosed bat roosting.

Horseback Riding and Grazing

Horses can be rented by the hour or day at the Buffalo Corral Riding Stables, located on the West Gate Road. Boarding of privately owned horses is also available. Three areas are used for grazing horses at Fort Huachuca (Figure 5). These three areas support approximately 50 - 60 horses. Use of these areas is rotated on 12 to 18 month rotation schedules.

Pasture A is approximately 946 acres and is used from May to October on a very infrequent basis. Pasture B is approximately 175 acres and is used between the months of March and May. Pasture C is approximately 312 acres and divided into two sections with rotation between the two. Horses are grazed in Area C from May to October. From November to February the horses are kept in a corral and the pastures are not grazed. Horseback riding is authorized across the installation with the exception of firing ranges (when in use) and impact areas.

Programmed Facilities Development

Programmed renovation and construction of facilities development projects support mission-related activities. Army projects programmed for construction within the current five-year planning cycle are listed in Table 3. These new military construction projects will occur within the cantonment area and within compatible land use areas (Figure 6). Facilities development projects include several military construction army projects targeted for construction along with two new Operation and Maintenance Army construction projects and several physical upgrades or improvements to existing buildings. An additional proposed construction, brought to our attention during consultation, and not reflected in Table 3 is construction of a 9-acre hard-surfaced extension to an existing military equipment parking area within the cantonment area (U.S. Army Reserve 1998).

Table 3: Facilities development

Short-Range Military Construction Project Listing (FY99-04)

FY	Project Description	Project No.	Scope	Unit of Measure	Funding
2000	Electronic Maintenance Shop	10106	21,300	SF	MCA
2000	CIDC Operations Building	10496	6,350	SF	MCA
2000	Bowling Center	43410	24	LN	NAF
2000	Whole Neighborhood Revitalization	41494	90	FA	MCA/AFH
2001	Effluent Reuse System	46756	--	--	MCA
2001	Renovate Golf Clubhouse & Irrigation	37016	30,000	SF	NAF
2001	Vehicle Maintenance Shop	47283	25,322	SF	MCA
2001	Whole Neighborhood Revitalization	49899	180	FA	MCA/AFH
2002	Whole Neighborhood Revitalization	31429	168	FA	MCA/AFH
2002	RV Park Expansion	45967	100	EA	NAF
2002	Electronic Maintenance Shop	47309	21,300	SF	MCA
2003	Whole Neighborhood Revitalization	31430	166	FA	MCA/AFH
2003	Vehicle Maintenance Shop	42779	11,304	SF	MCA
2003	Whole Neighborhood Revitalization	31434	163	FA	MCA/AFH
2004	Youth Center Addition	33321	5,332	SF	NAF
2004	Whole Neighborhood Revitalization	42752	146	FA	MCA/AFH
2004	Electronic Maintenance Shop	42782	10,631	SF	MCA

MCA = Military Construction Army NAF = Non-Appropriated Fund AFH = Army Family Housing
 LN = Lane SF = Square Feet FA = Family Unit EA = Each

Short Range Operation and Maintenance Army Project Listing (FY99-04)

FY	Project Description	Project No.
1998	BRAC Area Chapel	SR01
SR	Defueling Point Ramada & Utility Imp.	SR02

FIRE MANAGEMENT PLANNING

A fire management plan for Fort Huachuca was drafted by Robinett *et al.* (1997). The plan, when finalized and adopted by the Fort would become a part of the Integrated Natural Resource Management Plan. As of this writing, the plan has not been adopted in full by Fort Huachuca, but the programmatic guidance for fire planning in that plan is considered part of the proposed action by Fort Huachuca. That guidance, as well as portions of SAIC (1998a) pertinent to fire management are summarized here:

1. Policies to be followed in fire management include:
 - a. Protection of life (firefighter and public) is the first priority. Property, military training, and natural/cultural resources (including endangered species protection) are second priority.

b. Each prescribed fire shall be compatible with approved military training, public safety, or resource management objectives.

c. The use of prescribed fire shall be considered in establishing the management strategy for all ecosystems, particularly those determined to be partially or totally fire dependent.

d. Interagency (National Wildfire Coordinating Group 1979) prescribed fire qualification and certification standards will be implemented. A qualified and adequate work force will be trained and maintained to plan and implement managed fire projects safely and effectively. Each prescribed fire shall be conducted by qualified personnel in accordance with Western Region Prescribed Fire Qualification System.

e. Public health and environmental quality considerations will be incorporated into the use of managed wildland fire.

f. Once adopted, the Fort Huachuca Fire Management Plan will be reviewed on an annual basis and formally evaluated and reaffirmed every three years. Monitoring results from burns will be used in assessing the plan and making necessary revisions.

g. All areas with burnable vegetation will be allowed fire occurring at a reasonable return interval, except where occupied by human settlement. All areas below Charlie Break will be managed primarily by Fort Huachuca, while areas above Charlie Break will be managed primarily by the Coronado National Forest under an existing MOA.

h. Fires occurring in areas of human settlement (i.e. administrative sites, historic structures) will be suppressed immediately.

i. Fort Huachuca fire management policy in military training areas below Charlie Break is one of prescribed burning coupled with control of fires that occur in or near structures and/or occur in the grasslands and savannas outside of prescribed parameters. Ignitions started by tracer fire will be managed to consume fuels throughout the entire Small Arms Impact Range Area in a safe, prescribed manner.

j. US Forest Service and Fort Huachuca policy for woodlands and forests above Charlie Break allows for unplanned ignitions and management-ignited prescribed burning, as well as suppression (confine, contain, control) when appropriate. (Charlie Break runs roughly from the junction of Training Areas N, R, and S southeast to a point on the south boundary of Training Area U (Figure 1).

2. Prescribed (natural or ignited) fire shall be managed in accordance with the following guidelines. Implementation of prescribed fire will be contingent upon compatibility with military training, availability of funding and resources, and occurrence of correct burning conditions.

a. For each prescribed fire, Fort Huachuca will develop a prescribed burn plan that will include a description of the burn area, burn objectives, public safety issues, protection of sensitive features, range of expected results, weather and fuel conditions needed to achieve the desired fire behavior, containment procedures, pre-burn coordination (e.g. with the Service and the Coronado National Forest), monitoring plan, smoke management plan, and contingency plan.

b. The goals of prescribed burns on Fort Huachuca will include a) reducing fuel loads in military training areas to reduce the possibility of catastrophic fires, b) maintaining or improving wildlife habitat, including improving pronghorn antelope range away from firing ranges to reduce antelope foraging in burns near firing ranges, c) reducing the risk of catastrophic fires in habitats used by federally-listed threatened and endangered and candidate species, d) decreasing the likelihood of major fires in upper elevations that can cause an increase in erosion and decrease in water infiltration/recharge of aquifers, e) reestablishing the natural frequency/intensity of fires that would sustain flora and fauna biodiversity of Fort Huachuca, f) reducing the potential for fire to spread into the Fort's urban interface areas, and g) minimizing the threat of fire to the Fort's historical buildings and archeological sites.

c. Average fire return intervals should reflect the intervals of the natural fire cycle. Burn intervals in grassland, oak savanna, and pine-fir woodlands should average five-10 years. Burn intervals will vary, but intervals shorter or longer than the average will be appropriate in some areas to meet management or military training objectives. Fire intervals in agave management areas shall be once every 10-15 years.

3. Subject to available funding and resources, the Fort would take action to reduce woody fuels above Charlie Break. Fuel reduction could be accomplished by mechanical means, such as pruning, thinning; as well as prescribed fire.

4. Once adopted and incorporated into the Integrated Natural Resources Management Plan, Fort Huachuca will implement the Fire Management Plan to address suppression needs and prescribed fire. The plan will include guidelines related to resource personnel responsibilities; adjacent landowner responsibilities; fuels management; climatic monitoring; prescribed burning; smoke management; firebreaks; pre-suppression; and training, research, and equipment needs.

5. Post-wide wildfire suppression activities will include the following six fire management measures to prevent fires and aggressively control wildfires if they occur:

Provision of fire suppression trucks on-site during live fire exercises when deemed necessary by the Range Control Officer and Fort Huachuca Fire Department.

Maintenance of required firebreaks.

Avoidance of firing activities during high hazard conditions, such as strong winds.

Avoidance of the use of tracers during high to extreme fire danger periods.

To reduce the potential for adverse effects of fire suppression measures on listed and candidate species and their habitat, a biologist or other qualified environmental specialist will be available to serve as a resource advisor to provide guidance to individuals in charge of fire suppression activities.

TRAINING AREA ACTIVITIES

This section describes each of the training areas on the installation and the activities conducted in these areas. Information sources for this section include interviews with the Range Control

Officer, Air Traffic Control and Air Operations Personnel, annual range utilization surveys, and a supplemental study on training area utilization. This section discusses the infrastructure and facilities in the training areas, the military operations, and the recreational use of each training area. Table 4 provides a listing of individual training areas and the type of traffic (both on-road and off-road) permitted in each area. Training areas are shown in Figure 1.

Cantonment Area

The cantonment area and other developed lands at the post cover approximately 5,270 acres, or seven percent of the installation. The majority of the buildings and structures on the installation are located within the main cantonment area. More than 2,000 buildings are located within the cantonment area. The cantonment area provides the location for a variety of operational and testing facilities, maintenance and production facilities, research, development test and evaluation, supply facilities, hospital and medical facilities, administrative facilities, housing and community facilities, and utility and ground improvements, housing and community support services, as well as administrative and operational directorates and training facilities. Major command headquarters are located throughout the cantonment as well as maintenance and storage facilities, facilities for research, development and testing, medical care, and training. Within the cantonment and other built-up areas, land management activities and maintenance fall under the direction of the Directorate of Installation Support. All currently programmed construction activities in the existing five-year planning cycle are located within the cantonment areas (see Figure 6).

The following outdoor training facilities are located within the cantonment area:

Obstacle Course – Clover shaped with 17 obstacles. This course can be a test of the soldier's basic motor skills and physical conditioning;

Confidence Course – Clover shaped with four groups of higher and more difficult obstacles than the obstacle course. Designed to give soldiers confidence in their mental and physical abilities and cultivate their spirit of daring; and

Libby Army Airfield is located in the northernmost corner of the Cantonment area. This airfield consists of a 12,000 foot Class 'B' main runway on an east-west axis, a 5,365 foot secondary runway on a southeast-northwest axis, and a 4,300 foot tertiary runway running parallel to the main runway. Support facilities, including a flight control tower, a navigational aids building, an airfield operations building, an airfield fire and rescue station, and storage buildings are located along the southern side of the main runway and within the operational land use zone. Maintenance facilities and the City of Sierra Vista air terminal are on the north side of the airfield.

Table 4: Terrain Type and Traffic Permitted by Training Area

Training Area	Location By Range	Total Acres	Terrain Type	Traffic Permitted On Existing Road And Trails	Traffic Permitted Off Existing Roads and trails
Alpha	East	2471	High Desert	Foot/Wheel	Foot
Bravo	East	2471	High Desert	Foot/Wheel/Tracked	Foot
Charlie	East	2100	High Desert	Foot/Wheel/Tracked	Foot/Wheel/Tracked ¹
Delta	East	4694	High Desert	Foot/Wheel/Tracked	Foot/Wheel/Tracked ¹
Echo	East	4942	High Desert	Foot/Wheel	Foot
Foxtrot	East	3583	High Desert	Foot/Wheel/Tracked	Foot
Golf	West	1087	High Desert	Foot/Wheel	Foot
Hotel	West	4200	High Desert	Foot/Wheel	Foot
India	West	2223	High Desert	Foot/Wheel	Foot
Juliet	West	1111	High Desert	Foot/Wheel	Foot
Kilo	West	1136	High Desert	Foot/Wheel	Foot
Lima	West	840	High Desert	Foot/Wheel	Foot
Mike	West	1087	High Desert	Foot/Wheel	Foot
November	West	3410	Mountain	Foot/Wheel	Foot
Oscar	South	2619	Mountain	Foot/Wheel	Foot
Papa	South	3459	Mountain	Foot/Wheel	Foot
Quebec	South	2347	Mountain	Foot/Wheel	Foot
Romeo	West	1359	Mountain	Foot/Wheel	Foot
Sierra	South	2322	Mountain	Foot/Wheel	Foot
Tango	South	5312	Mountain	Foot/Wheel	Foot
Uniform	South	2347	Mountain	Foot/Wheel	Foot
Victor	South	1729	High Desert	Foot/Wheel	Foot
Whiskey	South	1482	High Desert	Foot/Wheel	Foot
X-Ray	South	1235	High Desert	Foot/Wheel	Foot
Yankee	South	1482	High Desert	Foot/Wheel	Foot
Zulu	East	6954	High Desert	Foot/Wheel	Foot

¹ Off-road wheeled and tracked-vehicle traffic is restricted to existing off-road maneuvering lanes. These lanes are currently inactive and have no programmed use.

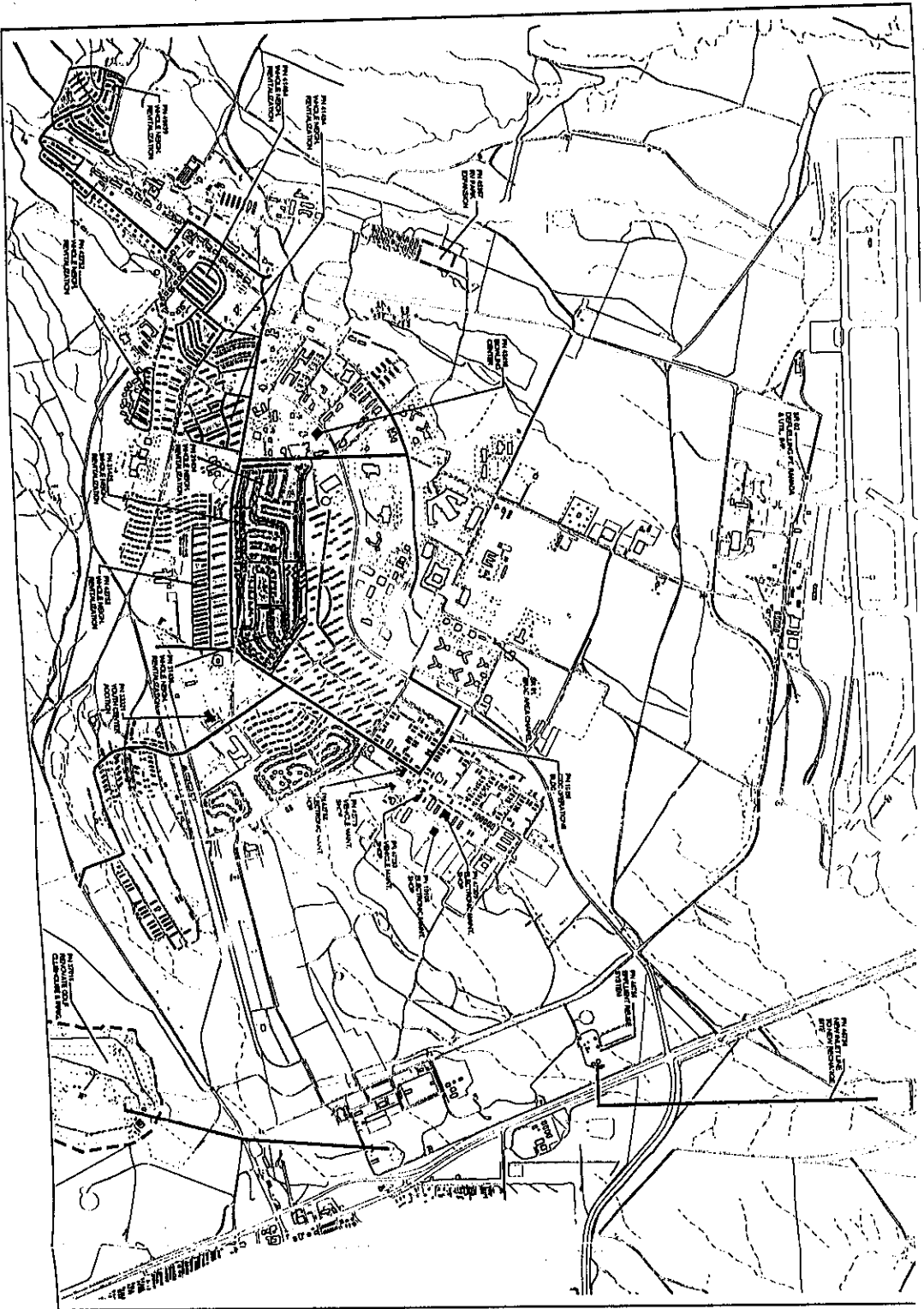
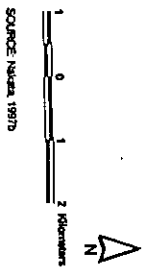


Figure 6: Facilities development projects.

Projects
Enclave System Release (PI 457-50)
Whole Neighborhood Revitalization



SOURCE: NABERS 1977

Training Area A (Alpha)

Training area Alpha is located in the East Range and covers an area of 2,471 acres. The area has a high desert terrain and is primarily used for intelligence and communications testing activities. During all such operations the vehicles are required by Range Control to stay on the existing roads and trails. Only wheeled vehicles are permitted in this area. No off-road vehicle use is permitted.

This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu (see Figure 4). These points support 60 & 80mm mortar, and 4.2-in mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. Use of areas outside of the preexisting firing points which are requested for use must be surveyed to 5th Order (1/1000) accuracy with accompanying environmental impact analysis prior to submission to Range Control for approval.

Training area Alpha is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, and permanent test sites.

Training Area B (Bravo)

Training area Bravo covers an area of 2,471 acres. The area has a high desert terrain and is primarily used for intelligence and communications testing activities. During all such operations vehicles are required by the Range Control to stay on the existing routes. Both, tracked and wheeled vehicles are permitted in this area on existing roads and trails. No off-road vehicle use is permitted.

Mortar firing into Area Zulu is permitted from this area upon approval from Range Control. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu (see Figure 4). These points support 60 & 80mm mortar, and 4.2-in mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. Use of areas outside of the preexisting firing points which are requested for use must be surveyed to 5th Order (1/1000) accuracy with accompanying environmental impact analysis prior to submission to Range Control for approval.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training

exercises. The area contains the Humor Drop Zone, a 2,700 by 5,450 feet area of sparse vegetation on the northern half of the training area used for air drops during Army National Guard training maneuvers. A portion of Hubbard Assault Airstrip is located in training area Bravo and comprises a dirt assault strip/landing zone surveyed and approved by the U.S. Air Force, which can accommodate C-130 aircraft (2,800 by 5,600 feet). Training area Bravo is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings, permanent test sites, and houses near post boundary.

Training Area C (Charlie)

Area Charlie, with an area of 2,100 acres, has a high desert terrain and is primarily used for intelligence and communications testing activities. During all such operations vehicles are required by the Range Control to stay on existing roads. Both, tracked and wheeled vehicles are permitted in this area on existing roads and trails.

Mortar firing into Area Zulu is permitted from this area upon approval from Range Control. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu (see Figure 4). These points support 60 & 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. Use of areas outside of the preexisting firing points which are requested for use must be surveyed to 5th Order (1/1000) accuracy with accompanying environmental impact analysis prior to submission to Range Control for approval.

This area also contains a portion of the approximately 5,172 acres within the East Range where off-road vehicle travel occurred up to 1994. No off-road vehicle activity presently occurs or is planned by Fort Huachuca. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises.

This area contains a portion of Hubbard Drop Zone (2,790 x 5,580 feet) and the majority of Havoc Drop Zone (2,790 x 5,580 feet). These are areas of sparse vegetation on the eastern and southern half of the training area used for air drops during Army National Guard training maneuvers. Training area Charlie is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings, permanent test sites, and houses near post boundary.

Training Area D (Delta)

This area, located between areas Charlie and Foxtrot, covers an area of approximately 4,694 acres. The area has a high desert terrain and is primarily used for intelligence and communications testing activities. During all such operations vehicles are required by the Range Control to stay on the existing routes. Both, tracked and wheeled vehicles are permitted in this area on existing roads and trails. No off-road vehicle is proposed.

Mortar firing into Area Zulu is permitted from this area upon approval from Range Control. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu (see Figure 4). These points support 60 & 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. Use of areas outside of the preexisting firing points which are requested for use must be surveyed to 5th Order (1/1000) accuracy with accompanying environmental impact analysis prior to submission to Range Control for approval.

This area contains a portion of the Hubbard Assault Airstrip which is a dirt assault strip/landing zone, surveyed and approved by the U.S. Air Force, that can accommodate C-130 aircraft (2,130 x 5,250 feet). The area also contains a portion of Hubbard Drop Zone (2,790 x 5,580 feet) and a small portion of Havoc Drop Zone (2,790 x 5,580 feet). These are areas of sparse vegetation on the northern edge of the training area used for air drops during Army National Guard training maneuvers. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises.

Training area Delta is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings and permanent test sites.

Training Area E (Echo)

At 4,942 acres, training area Echo is the largest training area on the East Range. The area has a high desert terrain and is primarily used for intelligence and communications testing activities. During all such operations vehicles are required by Range Control to stay on existing routes. Only wheeled vehicles are permitted in this area on existing roads and trails. No off-road vehicle use is permitted.

Mortar firing into Area Zulu is permitted from this area upon approval from Range Control. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu (see Figure 4). These points support 60 & 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. Use of areas outside of the preexisting firing points which are requested for use must be surveyed to 5th Order (1/1000) accuracy with accompanying environmental impact analysis prior to submission to Range Control for approval.

The area contains Hyena Drop Zone (980 x 980 feet). This area of sparse vegetation in the central portion of the training area is used for air drops during Army National Guard training maneuvers. The area also contains a dirt runway. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises.

Training area Echo is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings, permanent test sites, and houses near post boundary.

Training Area (F) Foxtrot

Training area Foxtrot, located between areas Charlie and Echo, has an area of 3,583 acres. The area is primarily used for intelligence and communications training and testing. The area has a higher level of military activity than other training areas on the East Range. Only wheeled vehicles are permitted in this area on existing roads and trails. No off-road vehicle use is permitted.

Mortar firing into Area Zulu is permitted from this area upon approval from Range Control. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu (see Figure 4). These points support 60 & 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. Use of areas outside of the preexisting firing points which are requested for use must be surveyed to 5th Order (1/1000) accuracy with accompanying environmental impact analysis prior to submission to Range Control for approval.

Located to the east of Libby Airfield, air space over portions of this area is located within landing and departure zones of primary runways. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. Area Foxtrot is divided into two game management areas, F1 and F2. Area F2 is closed to all hunting while area F1 can only be hunted with shotgun or bow and arrow.

Training Area G (Golf)

Part of the West Range, training area Golf is comprised of 1,087 acres of high desert terrain. The area is primarily used for intelligence and communications training and testing. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted. Air space over portions of this area is located within landing and departure zones of secondary runways at Libby Airfield. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises.

Area Golf is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings, permanent test sites, and houses near post boundary.

Training Area H (Hotel)

Training area Hotel's 4,200 acres is primarily used for intelligence and communications training and testing activities. Only wheeled vehicles are permitted on existing routes in the area. No off-road vehicle use is permitted. Testing and training sites located in protected agave management areas within this training area adhere to special use restrictions:

No firing of blanks or pyrotechnics within 0.25 miles of these areas.

Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

Night operations are prohibited from July through October.

Air space over portions of this area is located within landing and departure zones of primary runways at Libby Airfield. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. Portions of the installation grazing lands are located in this area.

Training area Hotel is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings, permanent test sites, and houses near post boundary.

Training Area I (India)

Training area India on the West Range has a land area of 2,223 acres. This area is primarily used for intelligence and communications training and testing activities. Only wheeled vehicles are permitted on existing routes in the area. No off-road vehicle use is permitted. Testing and training sites located in protected agave management areas within this training area adhere to special use restrictions:

No firing of blanks or pyrotechnics within 0.25 miles of these areas.

Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

Night operations are prohibited from July 1 through October 31.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. A helicopter landing pad is located within this area. Patrolling and tactics training is conducted in this area.

Area India is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings and permanent test sites. Antelope and Hidden ponds are located in the area.

Training Area J (Juliet)

Training area Juliet on the West Range covers a land area of 1,111 acres. This area is primarily used for intelligence and communications training and testing activities and UAV operations. Patrolling and tactics training are conducted in this area. Only wheeled vehicles are permitted on existing routes in the area. No off-road vehicle use is permitted. The Black Tower Joint Services UAV Training Complex is located on area Juliet. This consists of a permanent block of structures, temporary trailers, and buildings encompassing the Pioneer Training Facility, unpaved Rugge-Hamilton UAV runway, and the paved Pioneer UAV runway. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises.

Training area Juliet is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings, and permanent test sites. The Sycamore II pond is located in the area.

Training Area K (Kilo)

Training area Kilo covers an area of 1,136 acres on the West Range. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing routes in the area. No off-road vehicle use is permitted. This area contains Demonstration Hill and one Helicopter Landing Area for proficiency and emergency operations.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. Portions of the installation grazing lands are located in this area. Training area Kilo is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings and permanent test sites. The Laundry Ridge pond is also located in this area.

Training Area L (Lima)

Training area Lima covers an area of 840 acres and has a large percentage of its land under protected agave management. This area is primarily used for intelligence and communications training and testing activities. Patrolling and land maneuvering training are conducted in this area. Only wheeled vehicles are permitted on existing routes in the area. No off-road vehicle use is permitted.

Testing and training sites located in protected agave management areas within this training area adhere to special use restrictions:

No firing of blanks or pyrotechnics within 0.25 miles of these areas.

Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

Night operations are prohibited from July 1 through October 31.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. One large (40 acre) permanent bivouac site is located in the area. This site is approximately 6,600 feet from an Agave Management Area.

Training area Lima is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings and permanent test sites. The area has a picnic area for recreational activities.

Training Area M (Mike)

Training area Mike covers an area of 1,087 acres on the West Range. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training are conducted in this area. Only wheeled vehicles are permitted on existing routes in the area. No off-road vehicle use is permitted. Testing and training sites located in protected agave management areas within this training area adhere to special use restrictions:

No firing of blanks or pyrotechnics within 0.25 miles of these areas.

Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

Night operations are prohibited from July 1 through October 31.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. One large (40 acre) permanent bivouac site is located in the area. This site is approximately 1,650 feet from the Agave Management Area. A land navigation course is found in training area Mike consisting of 58 surveyed concrete points with ASA markers.

Training area Mike is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings, permanent test sites, and houses near the post boundary. Kino and Sycamore I ponds are located in the area.

Training Area N (November)

Training area November with an area of 3,410 acres is comprised of mountainous terrain. Military activities in the area are restricted to the relatively flat areas only. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training are conducted in this area. Only wheeled vehicles are permitted on existing routes in the area. No off-road vehicle use is permitted.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. This area contains one Helicopter Landing Area for proficiency and emergency operations.

For the purpose of game management, the area is divided into two parts, N1 and N2. Training area November is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings, permanent test sites, and houses near the post boundary. Blacktail pond is located in N-2 Game Management Area.

Training Area O (Oscar)

Training area Oscar covers an area of 2,619 acres and is a part of the South Range. As the general terrain of the area is mountainous, the military activities in the area are restricted to the relatively flat areas only. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training are conducted in this area. Only wheeled vehicles are permitted on existing routes in the area. No off-road vehicle use is permitted. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises.

Training area Oscar is among the areas most heavily used by recreationists. The Huachuca Canyon picnic area is located in northern part of the area. Training area Oscar is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings, and permanent test sites.

Training Area P (Papa)

Training area Papa covers an area of 3,459 acres and is a part of the South Range. As the general terrain of the area is mountainous, the military activities in the area are restricted to the relatively flat areas only. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training are conducted in this area. Only wheeled vehicles are permitted on existing routes in the area. No off-road vehicle use is permitted.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises.

The topography of the area contributes to the heavy use of the area by recreationists. Three picnic areas are located in the Garden Canyon area. Facilities in these recreation areas include play areas, grills, and ramadas. There are numerous hiking and horse back riding trails in this area. Recreational users are prohibited from rock climbing and rappelling. Training area Papa is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings and permanent test sites.

Training Area Q (Quebec)

Training area Quebec covers an area of 2,347 acres and is a part of the South Range. As the general terrain of the area is mountainous, the infrequent military activities in the area are restricted to the relatively flat areas and roads only. Only wheeled vehicles are permitted on existing routes in the area. No off-road vehicle use is permitted.

The topography of the area contributes to the heavy use of the area by recreationists. There are numerous hiking and horse back riding trails in this area. Recreational users are prohibited from rock climbing and rappelling. Upper Garden Canyon pond is located in this area. Training area Quebec is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings and permanent test sites.

Training Area R (Romeo)

Training area Romeo is part of the west range and has a land area of 1,359 acres. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. Testing and training sites located in protected agave management areas within this training area adhere to special use restrictions:

No firing of blanks or pyrotechnics within 0.25 mile of these areas.

Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

Night operations are prohibited from July 1 through October 31.

This area contains one Helicopter Landing Area for proficiency and emergency operations. Training area Romeo is also used for hunting activities. Hunters are required to observe a 0.25 mile safety zone around buildings and permanent test sites.

Training Area S (Sierra)

Training area Sierra is part of the South Range and has a land area of 2,322 acres. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training are conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises.

The topography of the area contributes to the heavy use of the area by recreationists. There are numerous hiking and horse back riding trails in this area. Recreational users are prohibited from rock climbing and rappelling. Split Rock cabin is located in this area. The area is used for hiking and hunting. Hunters are required to observe a 0.25 mile safety zone around buildings and permanent test sites.

Training Area T (Tango)

Located south of the Cantonment area, Tango has a land area of 5,312 acres. Seventeen live fire ranges are located in Tango. See Table 2 for range descriptions and the types of weapons used. See Figure 4 for locations of firing ranges. Training area Tango is used for personnel development training by almost all units on the installation. This area is a small arms impact area and although no explosive munitions are used, testing and training is not permitted in this area.

The area is divided into three game management areas (T1, T2, and T3). The area is used for hiking, hunting and fishing. Hunters are required to observe a 0.25 mile safety zone around buildings and permanent test sites. Gravel Pit, Woodcutters, and Fly ponds are located in this area.

Training Area U (Uniform)

Training area Uniform is part of the South Range and has a land area of 2,347 acres. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training are conducted in this area. Only wheeled vehicles are permitted on the existing routes in the area. No off-road vehicle use is permitted. A land navigation course is located on area Uniform. This course consists of 44 surveyed concrete points with ASA markers. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. Testing and training sites located in protected agave management areas within this training area adhere to special use restrictions:

No firing of blanks or pyrotechnics within 0.25 miles of these areas.

Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

Night operations are prohibited from July 1 through October 31.

The area is also popular for its recreational facilities. Picnic areas are located in this portion of Garden Canyon. The area is used for hiking, hunting and fishing. Hunters are required to observe a 0.25 mile safety zone around buildings and permanent test sites. Middle Garden Canyon and Tinker ponds are located in this area.

Training Area V (Victor)

Training area Victor covers a land area of 1,729 acres and has a desert type terrain. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training are conducted in this area. Only wheeled vehicles are permitted on the existing roads in the area. No off-road vehicle use is permitted. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. This area contains one Helicopter Landing Area for proficiency and emergency operations.

The area is divided into two subsections (V and V1) for game management. Area V has a golf course and the Golf Course pond; hunting is not permitted on Area V.

Training Area W (Whiskey)

Training area Whiskey covers a land area of 1,482 acres and has a desert type terrain. This area is primarily used for intelligence and communications training and testing activities. Site Boston FTX Site is located in area W. Large Brigade-level exercises are conducted in Site Boston. The 86th Signal Battalion conducts two Battalion level and one Brigade level exercise each year, with about 42 and 100 personnel respectively participating in the training. While 17 vehicles may be utilized at the Battalion level training, 42 are used at the Brigade level training. Activities during these training include radio systems training, setting tactical field sites, tents, antennas, and mobile kitchens. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on the existing roads in the area. No off-road vehicle use is permitted. Testing and training sites located in protected agave management areas within this training area adhere to special use regulations:

No firing of blanks or pyrotechnics within 0.25 mile of these areas.

Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

Night operations are prohibited from July 1 through October 31.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. The area is also used for hiking and hunting. Hunters are required to observe a 0.25 mile safety zone around buildings, permanent test sites, and houses near post boundary.

Training Area X (X-Ray)

Training area X-Ray covers a land area of 1,235 acres and has a desert type terrain. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training are conducted in this area. Only wheeled vehicles are permitted on the existing routes in the area. No off-road vehicle use is permitted. Testing and training sites located in protected agave management areas within this training area adhere to special use restrictions:

No firing of blanks or pyrotechnics within 0.25 mile of these areas.

Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

Night operations are prohibited from July 1 through October 31.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. The area is also used for hiking and hunting. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near the post boundary.

Training Area Y (Yankee)

Training area Yankee covers a land area of 1,482 acres and has a desert type terrain. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training are conducted in this area. Only wheeled vehicles are permitted on existing routes. No off-road vehicle use is permitted.

Large Brigade-level exercises are conducted in this area. The 86th Signal Battalion conducts two Battalion level and one Brigade level exercise each year, with about 42 and 100 personnel respectively participating in the training. While 17 vehicles may be utilized at the Battalion level training, 42 are used at the Brigade level training. Activities during these training include radio systems training, setting tactical field sites, tents, antennas, and mobile kitchens.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. The AEROSTAT operations facility and tethered balloon is located in this area. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary. Lower Garden Canyon pond is located in this area.

Impact Area Z (Zulu)

Impact area Zulu, also known as the Impact Zone, is a part of the East Range. This 6,954 acre area contains various types of targets for artillery and mortars. High explosive ammunition may be fired on this area. Some areas may contain unexploded ordinance. Range Control Operations has declared off-road areas in this zone permanently "off-limits" to recreational activities and warning signs are posted in the area to alert visitors and troops.

This area is sometimes used for intelligence and communications training and testing activities. ASA sites are located along existing roads and trails in this area and can be used for intelligence and communications testing and training. No off-road vehicle use is permitted. No recreation or hunting is permitted in this area.

Off-Post Activities Authorized or Carried Out by Fort Huachuca

The Fort leases for military training purposes approximately 2,600 acres from a variety of land owners, primarily in southeastern Arizona (Table 5). An additional 27,387 acres on the Willcox Playa, Cochise County, is withdrawn from public entry. Parcels leased vary in size from less than an acre to 1,280 acres on Willcox Playa, Cochise County. Although most leased/withdrawn land is in Cochise County, the Fort also leases land near Phoenix, Gila Bend, Oatman, Mount Graham, and Mount Lemmon, Arizona; Lordsburg, New Mexico; and Mt. Diablo, California. Many are ASA sites or communications sites (antennas, microwave towers, etc.). Others are pull-off sites along roadways where equipment is temporarily operated. Uses of each site are described in Table 5. Many of the equipment tests and field training exercises conducted by a variety of training units at Fort Huachuca require placement of equipment over a large geographic area.

Table 5: Land leases and withdrawals

CURRENTLY IN AP 403 TO
(AS OF 10 JUNE 99)

ITEM NUMBER	LEASE OR PERMIT NO.	TASK OR PROJECT	ACRES	EXPIRATION DATE	ANNUAL RENTAL	USE AND LOCATION	PERMITTER/LESSOR	REMARKS
1	BLM No. PJO 2183 91210 Gila Bend	USAEPO 1960 Fac No LP001	640	INDEF	NONE	Portions of SEC 23, 24, 25, and 26 T4S, R9W, Oatman Mt.	Dept of the Interior	Oatman Mountain Site
1a	BLM No. AR 035642 91310 Gila Bend	USAEPO 1976 Fac No LP059	N/A	INDEF	NONE	Right-of-way in SEC 7, T4S, R17W Maricopa County, Oatman Mt.	Dept of the Interior	Alt route to site (old file #2a) (1 ac in RPT)
2	BLM No. AR 028695 91310 Gila Bend	USAEPO 1960 Fac No LP002	13.77	INDEF	NONE	Portions of SEC 26, 34, 35, T4S, R9W Oatman Mt. Site R/W	Dept of the Interior	
9	LA 1330 91310 Gila Bend	USAEPO Fac No LP009	1.0	INDEF	NONE	Portions of SEC 23, T4S, R9W Oatman Radar Reflector Site	Dept of the Interior	Utility pole reflector site
21	LA 2146 91350 Ft Huachuca	USAEPO Fac No LP021	14.75 (15.0 in RPT)	INDEF	\$100.00 w/amend. #5	Mt. Lemmon, bldgs 195 (6,000SF) & P-13 (USFS bldg-3175F)	U.S. Forest Service	POC: Kim Rinehart/518-1816
27	LA 2349 BLM No. A7694 91310 Gila Bend	USAEPO Fac No LP027	.037	INDEF	NONE	Tract 27, T1N, R3W, Conomo & Data BLM Line, White Tank Mts. 20' x 60'	BLM - Joint Use	ASA sites 226, 233, 320
28	1. AZ 974512 2. AZ 972689	USAEPO ASA Sites	N/A	1. 31 Dec 99 Blanket Permit - Tucson 2. 31 Dec 99 Blanket Permit - Safford	NONE	Various roadside sites located along AZ State Highways: 80, 82, 90, & 92.	1. Arizona State Highway Dept - District 2, Area 2, Tucson 2. Arizona State Highway Dept - District 2, Area 3, Safford	ASA sites 176, 177, 178, 179, 222, 226, 233, 235, 236, 237, 251, 255, 256, 257, 265, 266, 314, 320, 390
32	LA 2427/A9227 91310 Ft Huachuca	USAEPO DTEP Fac No LP032	.34	INDEF	NONE	Test Site (.23 ac) & helipad (.11 ac) Mule Mountain	BLM - Joint Use	
34	LA 2439 91310 Ft Huachuca	USAEPO Fac No LP034	.1	31 Dec 03	NONE	Repeater Site, Heliograph Peak Electronic Site	U.S. Forest Service - Joint Use	Mt Graham Safford Ranger District, site is 24 miles from site 191/366
36	DACA04-98-0002 LA 48304 91360 Gila Bend	USAEPO (SPT) Fac No LP036	N/A	INDEF	NONE	P/SEC 26, T1SS, R4W, west of Gila Bend right-of-way under SP bridge	Southern Pacific RR - Joint Use	Alt route to site (see file #63)
37	DACA04-98-0002 AZ923-103417-64 92210 Wilhoit	USAEPO Fac No LL037	4.8	30 Sep 02	\$1,200.00	Tract No. 5, W1/2, of P/SEC 16, T1SS, R24E, West right-of-way, 100' wide strip of land; access to Wilcox Dry Lake	State of Arizona - Joint Use	

ITEM NUMBER	LEASE OR PERMIT NO.	TASK OR PROJECT	ACRES	EXPIRATION DATE	ANNUAL RENTAL	USE AND LOCATION	PERMITTER/LESSOR	REMARKS
40	DACA09-3-94-304 92210 Pt Hanchuca	11" Sig Bole Fac No LL040	8.3	30 Sep 00	\$1,000.00	P/SEC 3 & 4, T235, R27E, Bisbee-Douglas International Airport	Cochise County - Joint Use	USAEPG site 19 POC: SFC Whitaker S3, 11" Sig Bole 533-1539
41	DACA09-3-94-303 92210 Pt Hanchuca	11" Sig Bole Fac No LL041	10.0	30 Jun 01	\$1,300.00	Safford Airport: FTX site: SE1/4 SW1/4 of SEC 1, T7S, R28E, Q43RM, Graham County	City of Safford - Joint Use	Good w/owner required, POC: SFC Whitaker S3, 11" Sig Bole 533-1539
42	DACA09-3-94-320 AZ 23-346-44 92210 Pt Hanchuca	USAEPG Test Fac No LL042	1.84	01 Oct 99	\$1,200.00	Two test sites: P/SEC 29, T19S, R21E, (N. Hwy 82) & P/SEC 33, T19S, R21E (Gleason Rd)	State of Arizona - US Gov't Spec Land Use Permit	ASA sites 482 and 96
43	DACA09-3-94-3001 AZ 23-103319-44 92210 Pt Hanchuca	USAEPG Fac No LL043	10.0	30 Sep 02	\$1,200.00	Sandra Ranch Commo Site: P/SEC 2, T20S, R19E	State of Arizona - US Gov't Spec Land Use Permit	ASA 21
45	DACA09-3-94-306 91310 Pt Hanchuca	USAEPG Test Fac No LP045	92	INDEF	NONE	Commo Site - Hereford Rd: SEC 9, T23S, R22E	BLM - SPRCMA, Tucson District - Joint Use	Land adjacent to ASA 94; EPG has key (lock #E437)
47	DACA09-3-94-303 92210 Pt Hanchuca	USAEPG Test Fac No LL047	40.0	31 Mar 03	\$1.00 term	Tombstone Municipal Airport: Parcel #2, P/SEC 30, T20S, R23E	City of Tombstone - Joint Use	POC: SFC Whitaker, S3, 11" Sig Bole; 533-1539. Contact Mr. Rich Ng, 533-8084 prior to use. ASA 11 (FNU)
51	DACA09-3-94-3 AZ 23-34035-44 92210 Willow	USAEPG Fac No LL051	1.82	30 Sep 99	\$1,200.00	East Access off of Kansas Settlement Rd to Willcox Dry Lake: P/SEC 27, T14S, R25E	State of Arizona - US Gov't Spec Land Use Permit - Joint Use	POC: Rich Ng, 533-8084, fax 533-8018 files 46 & 90 Note
52	DACA09-3-94-33 AZ 66-96538-00 92210 Pt Hanchuca	USAEPG & JTRC Fac No LL052	60.0	30 Sep 99	\$1,000.00	Site Silty: P/SEC 26, T16S, R21E; 20 ac (EPG) & P/SEC 25, T16S, R21E, 40 ac (JTRC)	State of Arizona - US Gov't Spec Land Use Permit - Joint Use	ASA 377 & 648, POC: Rich Ng, 533-8084
53	DACA09-3-94-308 AZ 23-103411-44 92210 Pt Hanchuca	USAEPG Fac No LL055	18.76	30 Sep 02	\$1,200.00	Winchester Site: P/SEC 11 & 14, T13S, R22E, 2.47 acre (original site); added right-of-way (16.29 acres) in Apr 98	State of Arizona - US Gov't Spec Land Use Permit - Joint Use	ASA 499; POC: Rich Ng, 533-8084
56	DACA09-3-94-3081 92210 Willow	USAEPG Test Fac No LP056	9	INDEF	NONE	East entry to Willcox Dry Lake off of Kansas Settlement Rd (portion thereof) North 30", NE1/4, SEC 26, T14S, R25E	Robert G. Dycus PO Box 1801 Fishers, AZ: 85603 - Joint Use	Note files 51 and 90
58	LA 1000 AR 09785 RW 91310 Gila Bend	USAEPG Fac No LW058	3.56	INDEF	NONE	Stone Cabin site: SEC 19, T2S, R19W	BLM - Joint Use	Access off Hwy 95, 5.2 miles N of Yuma (includes old file #59). (Outgrants to USFWS (File #49) DAC A09 4 91 400, 11 ac & 1,571 SF of bldg and DPS (File 56) DAC A09 3-98 31, 64 SF of bldg X9001)

ITEM NUMBER	LEASE OR PERMIT NO.	TASK OR PROJECT	ACRES	EXPIRATION DATE	ANNUAL RENTAL	USE AND LOCATION	PERMITTER/LESSOR	REMARKS
61	LA 2312 BLM A-24204 91310 Gila Bend	USAEFG Fac No LP061	10.0	11 Feb 00	NONE	Oatman Mt. Maternal Borrow Site	BLM - Exclusive Use	
63	LA 1270 AR 029174 91310 Gila Bend	USAEFG Fac No LW063	10.0	INDEF	NONE	Gila Bend Commo Site (Forward Test Site); SENESEW of SEC 1, T4S, R4W	BLM - Exclusive Use	Previously contained metal bldg. 40' x 100'; subsurface. 'The Pit'
65	DACA09-9-96-116 NM ROW Easement No. 23994	11th Sig Bde FAC NO LL068	15.0	28 Apr 01	\$500.00	Lordsburg, NM FTX Site; SE1/4 of Sec 23, T25S, R18W, NMPM	State of New Mexico - Joint Use	POC: SFC Whittaker, S1, 11th Sig Bde x1-139
69	92210 Ft Huachuca DACA09-9-96-109 AZ 66-96601-00	USAEFG Fac No LL073	.63	30 Apr 00	\$1,200.00	Mustang Peak antenna site; SWNESEWNW, SEC 25, T20S, R18E	State of Arizona - Joint Use	POC: Rich Ng, 533-8084
75	92210 Ft Huachuca Permit No. 980603	USAEFG Trailblazer DT	N/A	10 Sep 99	\$33.00	County road side site	Cochise County Highway Dept - Joint Use	ASA 211, 218 & 261
80	Permit No 980601	USAEFG	N/A	10 Sep 99	\$33.00	Road side test sites; SEC22, T21S, R21E	Cochise County Highway Dept - Joint Use	ASA 404 (Charleston and N. Miamm Rd.)
83	Permit No 980602	USAEFG - Unnamed Test	N/A	10 Sep 99	\$33.00	County road side site	Cochise County Highway Dept - Joint Use	ASA 565
90	DACA09-9-96-1080 92210 Wilcox	USAEFG - AJSC Fac No LL050	1.82	INDEF	NONE	East entry to Wilcox Dry Lake off Kansas Settlement Rd (portion of entry access); N. 30', NE1/4 SEC 26, T14S, R25E	Mr. James T. Puls 2101 W. Detroit Street Chandler, AZ 85224 Joint Use	Also see files #51 & 56
91	Permit, LAS, & Agreements LAS	7" Special Forces	Varies	INDEF	NONE	BLM, USFS, Cochise/Santa Cruz Counties	BLM, USFS, Counties	Historic file
92		USAEFG - UAV, Aural/Visual Tests & Short Range	Varies	INDEF	NONE	Collie Springs - UAV; .25 miles NE of mile marker 19, Highway 83; SEC 36	USFS - Sierra Vista Ranger District Coronado National Forest	Historic file, EPG POC: Rich Ng 533-8084 Temporary use until 10 Sep 99
93	DACA09-9-96-2 Navy N62-474648P00Q12	USAEFG 1988 Fac No LP074	N/A	31 Jul 01	NONE	Mr. Diablo Microwave Fac; use of cabinet & lower space; Stockton, CA	US Navy, Naval Communications Station, Stockton, CA - Joint Use	EPG, POC: Rich Ng 533-8084
95	Permit No 980604	USAEFG SINCGARS	N/A	10 Sep 99	\$33.00	County road side site	Cochise County Highway Dept - Joint use	ASA 352 (old file #79)
96	PLO127 WD 91210 Wilcox	USAEFG 1958 Fac No LW001	27,386.9*	INDEF	NONE	Wilcox Dry Lake	Dept of the Interior	ASA 20,102 (old file #1a) *additional AZ State acres 1,280 (see file #15)

ITEM NUMBER	LEASE OR PERMIT NO.	TASK OR PROJECT	ACRES	EXPIRATION DATE	ANNUAL RENTAL	USE AND LOCATION	PERMITTEE/LESSOR	REMARKS
99	Permit Nos 900817 & 900818	USAEFG JTIDS Test	N/A	31 Aug 99	\$70.00	County road side sites	Cochise County - Highway Dept Joint Use	ASAC: 282.872
101	Permit No 900709	TEXCOM - Ground TRAILBLAZER	N/A	09 Jul 99	\$315.00	County road side sites; Sibyl Rd (3 ea), Cacabel Rd, Post Ranch Rd, I-10 Frontage (E. of Benson), & Pomerene	Cochise County - Highway Dept Joint Use	Sites G,H,J,K,L,P,R,U,V. TEXCOM POC: Jim Simb, 518-6159/RR21(fax)
104	1. Permit Nos 901201, 901202, 901203, 901204, 901205, 901206, 901208, 901209, 901207, 901210. 2. Permit NO 3004	USAEFG SANDBLAST	N/A	1. 27 Nov 99 2. 06 Feb 00	1. \$350.00 2. \$0.00	1. County road side sites 2. City of Sierra Vista right-of-way permit	1. Cochise County - Highway Dept Joint Use 2. City of Sierra Vista - Joint Use	1. ASAC: 225.214.259, 661.1033.1581.1582, 1583.1584.1591. 2. ASAC: 1580 - City of Sierra Vista, Synder Blvd & Avenida Del Sol
105	USFS - Lr of Auth	TEXCOM-Air SHORT RANGE	N/A	INDEF	NONE	Operational testing of EPG's Short Range UAVs	USFS - Sierra Vista Ranger District Comando National Forest	POC: Duane Bennett, 378 0111
106	Variable	111 th MI BDE INTEGRATED FTX	Varies	Varies	NONE	Electronic testing along highway right-of-way N & E of Ft Huachuca	ADOT, USFS, Cochise County	PNC: CP1 Herline 513-3630
108	DACA04-0-90-1 91340 Gila Bend	USAEFG Fac No LP108	2.3	INDEF	NONE	Old Hwy 84, right-of-way, Gila Bend, AZ, Sections 3 & 4, T6S, R4W, G4SRM, Maricopa County, AZ	Steven L. Holt & Duane Holt P.O. Box 30 Gila Bend, AZ 85337	POC: Steve Holt, Gila Bend, AZ, (602) 683-2449
110	1. PLO 1471 2. PLO 6788 91310 FT HUACHUCA	1. USA 1937 FAC NO LW001 2. USA 1990 FAC NO LW001	1. 13,463.27 2. (2,040)±	1. INDEF 2. 06 AUG 10	NONE	RD&E: one half of East Range, Ft Huachuca, AZ	Dept of Interior	*Mineral rights acreage withdrawn is a part of the 13,463 acres

The largest leases/withdrawals are in the Willcox Playa, where Fort Huachuca controls 27,387 acres. The entire site is fenced and closed to public entry. The Electronic Proving Ground has established a Radar Geometric Fidelity Test Facility on the floor of the playa. The playa is also used for conducting various other classified military electronic and communications equipment tests, which involve using a number of ASA sites on the playa. In 1965, the Fort authorized construction of the Radar Geology Test area on the playa for the National Aeronautics and Space Administration in support of the lunar landing program. The facility is still in place, but is no longer used.

Additional information on descriptions of off-post activities can be found in the following environmental assessments: 1) "Military Training and Communications - Electronics Testing at Fort Huachuca", and 2) "Renewal of Six Joint-Use Property Leases in Support of the U.S. Army Electronic Proving Ground."

Realty Actions

Fort Huachuca has the authority to exchange, acquire, or dispose of lands to benefit their mission. Currently only one realty action is planned, although others may be proposed during the life of the project. The Fort proposes to exchange a 26-acre parcel near Kayetan Drive and Buffalo Soldier Trail to the Arizona State Land Department for State inholdings on the East Range. This exchange was authorized by special State legislation in 1987. The City of Sierra Vista has proposed to acquire from Fort Huachuca 203 acres adjacent to Libby Airfield pursuant to the Airport Improvement Act. The land would be used for aviation-related uses. If this or other realty actions occur, they would be the subject of National Environmental Policy Act compliance and separate consultation.

Infrastructure

Fort Huachuca maintains and operates a number of facilities and conducts activities associated with operating a military installation. These include 1) operation and maintenance of a 3.1 million gallon per day capacity wastewater treatment plant, 2) collection of solid wastes, and disposal primarily at the Huachuca City landfill, but some material goes to the Elfrida landfill, 3) a recycling program for paper, aluminum cans, glass, and various types of plastics that produced approximately 2,250 tons in 1994, 4) a network of roads, most of which are primary or collector streets in the cantonment area, but also there are many unpaved routes on the training ranges, 5) operation of three gates to the installation: the Main, East, and West Gates, 6) distribution and use of electricity supplied by Tucson Electric Power Company (Fort Huachuca used 105,712,000 kilowatt hours in 1997), 7) distribution and use of stationary

fuels, such as natural gas furnished by Southwest Gas Company, and propane, 8) distribution, storage and use of vehicle and aircraft fuels, and 9) operation of a Hazardous Material Center (hazardous material storage complies with Occupational Safety and Health Administration hazardous communications standards and National Fire Prevention Association standard codes, and an Installation Spill Contingency Plan, dated December 20, 1996, describes the procedures for dealing with spills of hazardous materials - the January 1997 Installation Hazardous Waste Management Plan provides necessary procedures for accumulation, storage, transportation, and disposal of hazardous wastes in compliance with applicable State and Federal regulations.)

Proposed Mitigation Measures

The Fort's biological assessment contained many measures to mitigate the effects of the proposed action on listed and proposed species and critical habitat. Additional measures were agreed upon during the consultation process, the most important of which appear in a Memorandum of Agreement signed concurrently with this biological opinion (Appendix 1.) Fort Huachuca proposes the following measures to reduce adverse effects of the proposed action on listed species and critical habitat:

1. Army Water Resources Management Plan.

The primary purpose of the Army Water Resources Management Plan is to maintain the Army's mission at Fort Huachuca while protecting and maintaining populations of listed species and their habitats. To meet this goal, the Army will reduce its impact on the subwatershed's water resources. Towards this end, the Army will identify potential water conservation and effluent reuse and recharge projects for implementation. The Army has reduced its water usage by 34 percent during the last 10 years and will continue to reduce its annual net water consumption (pumping minus recharge) over the next 10 years covered by this opinion. Proposed projects may be implemented off lands under Army ownership or control. Implementation of specific projects must not interfere with the Army's national defense or national security mission. In recognition of uncertainties with recharge technology, mission changes, etc., the Army will consult with the Service on any changes in the Army's ability to reduce its net water consumption over the next 10 years.

In addition to the measures listed above, the Army agrees to the following measures to support the goal of the Army Water Resources Management Plan:

- A. Conserving water use by all users to the level necessary to meet, but not exceed, their basic and reasonable needs,

- B. Increasing the supply of groundwater to limit the growth of the cone of depression caused by pumping to serve Fort Huachuca and the City of Sierra Vista,
- C. Developing a monitoring program designed to assess progress,
- D. Or other actions that may be identified through the planning process that would contribute to meeting the goal of the Army Water Resources Management Plan.

This Army Water Resources Management Plan will include potential water conservation and recharge projects, which the Army will seek to have incorporated into the Upper San Pedro Partnership Regional Water Resources Management Plan. The Upper San Pedro Partnership was created in 1998 and has already made significant progress, including developing a list of potential water conservation and recharge projects that could be implemented in the subwatershed. The Army will continue to be an active participant within the Upper San Pedro Partnership, setting an example through its implementation of the following projects:

In order to reduce net annual water consumption, the Army will implement some or all of the following water conservation measures, and/or other measures identified during the planning process:

- A. Winning the Infrastructure War (demolition of excess buildings and infrastructure)
- B. Modernize golf course irrigation system
- C. Installation of additional waterless urinals in high use areas
- D. Xeriscaping of lawns around buildings
- E. Use of gray water in residential and barrack areas
- F. Conduct periodic water leak detection surveys
- G. Change watering policy and aggressively enforce it
- H. Implement conservation technology
- I. Closure of garden plots

In order to reduce net water consumption, the Army will implement some or all of the following water recharge and effluent reuse projects, and/or other measures identified during the planning process:

- A. Measure effluent and stormwater recharge from East Range effluent ponds
- B. Re-engineer East Range effluent ponds to increase recharge
- C. Implement Hatfield pilot recharge project

- D. Study and implement Huachuca Creek recharge project
- E. Restore East Range drainages to increase recharge
- F. Implement Buffalo Soldier Trail recharge project
- G. Capture water discharge into sanitary sewer
- H. Capture additional stormwater
- I. Encourage community water reclamation projects
- J. Support pilot in-channel recharge/erosion control projects
- K. Eliminate groundwater pumping near the San Pedro RNCA

In addition to implementing some or all of the proposed projects above, the Army will continue to support hydrogeologic research in the subwatershed to gain a better understanding of the hydrology and how it may be affected by cultural water uses. It is important to accurately define the cone of depression and implement recharge projects to benefit surface flow in the San Pedro River. Funded by the Army in fiscal years 97 and 98 (\$360K) through a partnership with USGS, geophysical hydrology subsurface surveys are an important tool in understanding this physical system. The data provide insight into the cone of depression, underground reserves, and structures, which impact flow to the San Pedro River. Ongoing work will provide additional information to improve water management in the subwatershed. In addition, areas of the subwatershed will be resurveyed and compared to baseline information. Future efforts will provide validation of recharge estimates and changes in the hydrologic regime. Another important Army initiative is the Alternatives Futures Study. This effort, already funded at approximately \$1.6 million, will develop and evaluate a series of possible future scenarios for the region, comparing their relative impact on a number of environmental and other parameters. The results will be useful for integrated ecosystem management and other planning in the region. The study will incorporate some data from Mexico, where the headwaters of the San Pedro River are located, and may help to identify some water use savings that could be captured through international cooperative efforts.

In addition to active participation in the Upper San Pedro Partnership Plan, the Army will continue to cooperate with local, state, and federal entities on workgroups and technical information sharing (Technical Review Committee), in close coordination with surrounding communities and Cochise County.

The Army Water Resources Management Plan will be reviewed annually by the Service. The Army will prepare an annual written report to the Service documenting progress and results in implementation of proposed projects.

2. Regional Water Resources Management Plan: The Army's water resources management efforts are intended to complement ongoing and future regional water conservation and recharge efforts carried out by city, county, state, Federal, and private entities within the subwatershed. The Regional Water Plan is likely to be an outgrowth of the planning efforts of the Upper San Pedro Partnership but other forums may emerge for developing this plan.

A general concept to be used in preparing and implementing a Regional Plan will be that each water user within the subwatershed should mitigate their own impact on the subwatershed's water resources and contribute to a regional effort to maintain sufficient baseflows in the San Pedro River to sustain species and habitat protected by the Endangered Species Act. The Army will work with other partners to actively promote and participate in the development of a Regional Plan for the subwatershed, including providing funding, technical assistance, and other support as needed to complete and begin implementation of a Regional Plan within three years. The Plan may include acquiring and retiring water rights in the area, balancing use with conservation and recharge projects, importing water, or any combination of these and other yet to be identified methods for attaining a balance between groundwater withdrawals and recharge sufficient to ensure continued baseflows in the upper San Pedro River.

3. Point of Contact: To improve assurances that operations will be conducted in compliance with environmental requirements including any terms and conditions and reasonable and prudent measures in this opinion, project design will include designating a management representative (point of contact) within the Range Control Operations office. This management representative would have the duty to ensure compliance with mitigation measures by all users of the installation. This representative will have the authority to halt activities that may be in violation of such measures. The management representative will coordinate with the Fort Huachuca Environment and Natural Resources Division who will coordinate with the Service on all matters concerning mitigation and management responsibilities.

4. Training and Fire Suppression Capability: Unit commanders would be responsible for ensuring that unit personnel are adequately trained in natural resource protection procedures, that the unit has adequate fire suppression capabilities, and that all restrictions or guidelines for training or testing are followed. Failure to follow all range procedures would result in loss or limitation of range privileges at the discretion of the Range Control Officer.

5. Erosion Control: The Fort shall implement the East Range watershed improvement plan (Fort Huachuca 1997a), which identified watershed improvement strategies and best management plans such as check dams, revegetation and reseeding actions to retard erosion on the East Range of the installation. Other erosion control measures proposed on the training ranges include scheduling training during the driest seasons (April through June), when

possible, and allowing sufficient time for soils to dry after heavy rains before resuming training. Implementation will be subject to available funding.

6. Monitoring and Surveying of Listed and Candidate Species: Fort Huachuca will continue to periodically monitor and survey for listed and candidate species at the Fort (see Appendix 1 for specific monitoring protocols and schedules).

7. Implementation of Integrated Training Area Management (ITAM): The objectives of ITAM include the avoidance of extreme environmental damage and destruction of habitat for sensitive species; conservation and enhancement of natural resources; and compliance with the Endangered Species Act. There are four main components to the ITAM program. The Land Condition Trend Analysis program monitors changes in resources in terms of current land use and evaluates the capability of the land to meet the multiple use demands of the Army on a sustained basis. The Environmental Awareness program provides soldiers and leaders with handbooks, cards, and instructional videos on how to avoid environmental damage to training areas. The Land Rehabilitation and Maintenance program involves the repair of damaged land and the use of structural and vegetative measures to avoid future damage to training lands. The Training Requirements and Integration program sites military missions on land capable of supporting specific training activities. Through the latter program, training activities are rotated between sites to allow habitats time to recover from the adverse impacts of field training. Fort Huachuca has initiated implementation of the ITAM program; however, funding for the program has been suspended. The Fort intends to continue the program if and when funding becomes available.

8. Wildfire Prevention/Suppression: The Fort Huachuca Fire Department would continue to receive aid under the mutual aid agreements in place with the U.S. Forest Service, Sierra Vista, Huachuca City and Palominas Fire Departments in the event of major fires. In addition to the mutual aid agreements, Fort Huachuca has a Memorandum of Understanding with the U.S. Forest Service that would allow Fort Huachuca access to the National Wildfire Coordinating Group and the provision by the U.S. Forest Service of one Type 7 engine, one slurry bomber, and two U.S. Forest Service personnel to be stationed at the fort from April 1 to August 1. Fort Huachuca would continue to pay the U.S. Forest Service \$30,000 a year for this additional protection. The Range Control Officer and Fort Huachuca Fire Chief would continue to have the authority to restrict activities on the range at any time to prevent wildfire.

9. Agave Management: The objective of agave management is to maintain self-sustaining natural populations of *Agave palmeri* on Fort Huachuca and to ensure the continued protection of these populations from natural and human threats. Implementing this objective will help protect the forage base of the lesser long-nosed bat. Activities include the identification of areas to be protected based on recent surveys; exclusion of tracked vehicles,

pyrotechnics, and off-road training from these areas; and active fire suppression in these areas. The Range Control Officer will be responsible for implementation of and compliance with protection measures. The Fort will fully implement as soon as possible the Agave Management Plan (Howell and Robinett 1996) (see item 14 of the Army Requirements for the lesser long-nosed bat in Appendix B of the MOA - attached as Appendix 1 to this biological opinion).

The Agave Management Plan includes strict guidelines for controlling fires in the vicinity of protected agave stands. Significant agave stands will be identified and designated for the following 4 protection measures.

These training areas, as well as the rest of the South and West Ranges, will be off-limits to all off-road vehicle travel including armor and tracked vehicles.

Pyrotechnics will be banned from use within these areas.

Fires in these areas will be actively suppressed unless the area is approaching its natural fire return interval of 10 years, in which case a prescribed burn may take place.

Training and test sites in these areas will not be used by personnel on foot unless the activity has a range control-approved plan for fire suppression and appropriate fire fighting equipment.

The Agave Management Plan also provides for prescribed burns in or near agave stands, including protecting the densest areas of agaves within prescribed burn areas, and prohibiting prescribed burns in areas with agave densities greater than 259 plants per square mile where greater than half that number are young age classes (Howell and Robinett 1995).

10. Range Management: The role of range managers, particularly the Range Control Officer, in assuring adherence to natural resource protection measures is critical to the success of the mitigation measures. The Range Control office has the responsibility to review training forms, inspect training and testing units, inspect use of training areas, and monitor the training area conditions. In addition to existing range management procedures, the following procedures will be implemented to enhance compliance with management protocols:

Revision and implementation of Fort Huachuca Regulations 385-8, Range and Training Area Operations, to specify the completion of environmental awareness training (including protected resource identification) prior to the initiation of training or testing; and the responsibility of the unit commander to become familiarized with environmental policies and operational requirements.

Revision and implementation of Fort Huachuca Reg 385-8 to prohibit off-road vehicle traffic in protected agave management areas.

Implementation of policies to specify limits to range access during certain seasons to minimize effects on agave plant populations, riparian zones, erodible soils, and any areas identified for non-use for purposes of restoration, reseeding, recovery, or protection.

Provision of unit commanders with a checklist of required activities prior to initiation of training or testing, including environmental awareness training, familiarization with current protected or restricted areas, provision of fire suppression equipment, and assurance by the appropriate environmental office that the testing or training activity is in compliance with NEPA and Endangered Species Act requirements.

Implementation of erosion control measures to reduce erosion throughout the installation (i.e. gabions, runoff control structures, revegetation) where appropriate and as funding becomes available.

11. Recreation Management: As an open installation, Fort Huachuca permits recreational access to most portions of the South and West Ranges except during periods of military operations. Current restrictions on recreation prohibit night travel in recreational portions of Garden and Huachuca Canyons. The following recreation management measures will be implemented to reduce the risk of accidental fire, human disturbance, or direct mortality to federally-listed threatened and endangered and candidate species (see Appendix 1 for additional information concerning scheduling of implementation):

Construction of exclosure fencing or other barriers such as boulders around known populations of Huachuca water umbel to prevent accidental crushing of individual plants by persons or vehicles (completed).

Improvement of the current off-road vehicle policy.

Protection of ponds inhabited by the Sonora tiger salamander and other amphibians from disturbance by vehicles, including recreational vehicles (completed).

Development of a recreational regulation on Fort Huachuca to address issues relating to recreation on the installation.

Upgrading the entry alarm system and protection barriers at caves where lesser long-nosed bats are known to roost to prevent disturbance during roosting period.

12. Environmental Awareness Education: The environmental awareness program under ITAM (if funded) would provide operational units with maps, handbooks, cards, and videos designed to enhance the ability of the units to identify and protect sensitive resources. Information regarding the distribution and abundance of sensitive resources is currently maintained by the Environment and Natural Resources Division. The Range Control Officer,

who is responsible for distributing educational materials to operational units, will meet annually with personnel from the Environment and Natural Resources Division to verify the location of protected resources and restricted areas. Maps delineating protected resources and restricted areas will be updated annually as needed by the Range Control Officer in cooperation with Environment and Natural Resources Division personnel to reflect the most recent survey data and other information. These maps will be provided to operational units prior to initiation of training or testing activities. Additional environmental awareness training will be carried out for listed species (see Appendix B of the MOA, attached as Appendix 1 of this opinion).

Environmental awareness handbooks, cards, and videos will also be updated as needed to comply with current status and knowledge of listed, proposed, and candidate species at and near Fort Huachuca. Because of the number of protected species known or with potential to occur in the vicinity of Fort Huachuca, a two-year update cycle is recommended by the Fort.

13. Monitoring: General conditions of vegetation and soils at Fort Huachuca are monitored through the LCTA program. Existing monitoring of federally-listed threatened and endangered species will continue and be expanded consistent with the MOA attached as Appendix 1 to this opinion. In addition, *Agave palmeri* populations on Fort Huachuca will continue to be monitored no less than once every five years. Periodic surveys for other species including candidate species with potential to occur on Fort Huachuca will be conducted as appropriate.

14. Groundwater Studies and Usage: The Fort commits to undertake additional research intended to reduce uncertainty associated with groundwater issues. One study, which began in 1998, will examine the population structure, trends, and projections for future growth in Cochise County. This study will attempt to quantify the Fort's contribution to the increasing population of the county, as well as other factors.

Additional investigations into the connectivity of the Fort Huachuca/Sierra Vista well fields and San Pedro River flows will also be conducted. While the specific focus and design of these studies have not yet been determined, Fort Huachuca is committed to help improve the current state of knowledge regarding the groundwater resources of the region. The results of all investigations will be made available to the Service. Based on the results of these studies, Fort Huachuca will seek consultation with the Service as appropriate if significant changes in the current understanding of regional groundwater resources are found.

Fort Huachuca will continue to study potential effects of groundwater pumping and identify appropriate measures to reduce impacts. Study results would be made available to the Service

and regional hydrological researchers, and Fort Huachuca will seek consultation with the Service as appropriate.

Fort Huachuca will install composting latrines and extend water supply lines to the AEROSTAT facility to remove commercial and industrial use of spring water in Garden Canyon.

15. Individual Species Research: Fort Huachuca will develop and fund as appropriate, research studies on federally-listed threatened and endangered as well as candidate species and their habitat that occur on the installation. These studies shall include but not be limited to such areas as habitat condition assessment and trends analysis, habitat requirements, population surveying, habitat preservation plans, and species reintroduction studies. These research studies will be coordinated by Environment and Natural Resources Division and with an appropriate Service representative as necessary.

16. Integrated Natural Resource Management Plan: Fort Huachuca will complete the draft Integrated Natural Resources Management Plan (Environment and Natural Resources Division 1997) which will provide a comprehensive natural resource management plan for resource managers and installation tenants. This plan will combine all aspects of ongoing conservation measures and proposed mitigation addressed in this proposed action into a programmatic environmental program which will guide Fort Huachuca's environmental stewardship in the future.

17. Endangered Species Management Plans: Fort Huachuca will develop, as appropriate, endangered species management plans for federally-listed threatened and endangered as well as candidate species and their habitats that occur on the installation. These plans shall include but not be limited to such areas as habitat condition improvement and preservation plans. These species management plans will be coordinated by the Environment and Natural Resources Division and with the Service as necessary.

18. Species Specific Management: Specific mitigation measures in addition to the above measures will be implemented for all species addressed in formal consultation herein. These measures are found in the Appendix B of the MOA (Appendix 1.)

SCOPE OF THE CONSULTATION

This consultation is at the plan-level, in that the effects of the Fort's activities are evaluated broadly over a large range of programs and actions into the year 2009. However, this opinion is designed so that all aspects of the Fort's activities discussed herein are addressed to the

project level. In other words, the Service believes most or all activities described in the "Description of the Proposed Action" require no further consultation unless one of the reinitiation criteria are met (see "Closing Statement"). The Service offers this perspective for planning purposes only. In any case, the Fort has the responsibility under section 7(a)(2) of the Act and 50 CFR 402.14(a) to review its actions to determine whether any action may adversely affect a listed species or critical habitat, and if such a determination is made, to enter into formal consultation with the Service if that action has not been the subject of previous consultation. Program or project-level components of the proposed action that we suggest the Fort examine closely to determine if additional project-level consultation is necessary include the Army Water Resources Management Plan, the Regional Water Resources Plan, and the Integrated Natural Resources Management Plan and components therein including the Fire Management Plan and Endangered Species Management Plans. We also encourage the Fort to look closely at possible effects of off-post activities, which were not described in any detail in SAIC (1998a). Maintenance or operations of facilities in some sensitive or species-rich areas, such as Mount Lemmon and Mount Graham, Arizona, and Mount Diablo, California, could result in effects to listed species not evaluated herein or in SAIC (1998a). Aircraft overflights, particularly low-level flights, that originate at Fort Huachuca or that could not occur but for landing strips or facilities at Fort Huachuca (these activities and their effects would be interrelated or interdependent to activities at Fort Huachuca - 50 CFR 402.02) may also have effects not evaluated herein or by SAIC (1998a). Aspects of the Fort's activities not described in the "Description of the Proposed Action" and evaluated in the "Effects of the Proposed Action" herein are not covered by this opinion. The Fort has committed to consulting on any such activity that may affect listed species or critical habitat (part 5.c.13 of the MOA in Appendix 1).

An aspect of the proposed action for which effects to listed species and critical habitat are difficult to determine with precision is future prescribed fire, or managed natural fire. The location, extent, timing, and logistics of such projects, and subsequent effects to listed species and critical habitat are difficult to predict. As a means to extend the consultation to the project level for these components of the proposed action, the Fort and the Service have established a process whereby as the details of such projects are developed, their effects can be evaluated and mitigation developed and implemented under the umbrella of this opinion. For such projects, this opinion programmatically anticipates certain effects, including incidental take. The Service believes that no further consultation on these projects is required so long as none of the reinitiation criteria are triggered and the Service approves mitigation plans for the projects. In considering whether or not to approve mitigation plans, the Service will determine if the type of project proposed and the nature of impacts anticipated fall within the scope of activities and impacts described herein. In making this determination, the Service will carefully evaluate the additive effects (number and impacts of all such projects authorized under this opinion) to ensure that the sum total of such projects do not exceed the extent or nature of that evaluated here, that impacts do not exceed that anticipated herein, and that any anticipated take would not be met or exceeded. If anticipated effects of proposed projects

exceed that described herein, the project type is not included herein in the "DESCRIPTION OF THE PROPOSED ACTION", or anticipated take would be met or exceeded, the Service will not approve the mitigation plan and, in accordance with 50 CFR 402.14(a), the project would be subject to additional section 7 consultation if the Fort determines that the project may affect a listed species or its critical habitat.

This opinion evaluates all effects of the proposed action, including interdependent and interrelated effects (50 CFR 402.02), some of which occur off-post. Although such effects are addressed herein, reasonable and prudent measures and terms and conditions only apply to discretionary Army actions, not actions conducted by private individuals, the State of Arizona, County of Cochise, the City of Sierra Vista, or others that do not require authorization from the Fort. Anticipated incidental take in the "Incidental Take Statements" for animal species is based on these effects analyses, and the Fort is exempted from incidental take prohibitions in section 9 of the Act so long as such take is in compliance with the incidental take statements. Take statements only apply to activities funded, authorized, or carried out by the Fort and do not authorize take by private individuals, contractors, recreationists, or others, unless such take is incidental to an action that is authorized by the Fort, described in the "Description of the Proposed Action", and evaluated in the "Effects of the Proposed Action."

ANALYSES BY SPECIES:

The following section includes separate analyses for each of the five listed species considered in this biological opinion. Analyses include a status of the species, environmental baseline, effects of the proposed action, concluding findings, and incidental take statements for animal species (with the exception of the southwestern willow flycatcher). Incidental take statements include reasonable and prudent measures and terms and conditions, which are mandatory actions that must be carried out by the Fort so they become binding conditions of any grant or permit issued to a permittee or contractor. In this case, measures to minimize take were included in the MOA (Appendix 1), and are merely referenced in the incidental take statements. The Service expects that these measures will be implemented as soon as possible. Failure to promptly carry out terms and conditions may nullify the exemption from incidental take under of section 7(o)(2) of the Act and leave the Fort and/or its permittees/contractors subject to prosecution for an unlawful take.

Terms and acronyms used in the following discussion are discussed and defined in the "DESCRIPTION OF THE PROPOSED ACTION" and SAIC (1998a).

Huachuca Water Umbel

STATUS OF THE SPECIES

The Huachuca water umbel was listed as an endangered species on January 6, 1997. Critical habitat was designated July 12, 1999, on 33.7 miles of the upper San Pedro River, 3.8 miles of Garden Canyon on Fort Huachuca, and other areas of the Huachuca Mountains, San Rafael Valley, and Sonoita Creek. The umbel is an herbaceous, semiaquatic perennial plant with slender, erect leaves that grow from creeping rhizomes. The leaves are cylindrical, hollow with no pith, and have septa (thin partitions) at regular intervals. The yellow/green or bright green leaves are generally 0.04-0.12 inch in diameter and often one to two inches tall, but can reach up to eight inches tall under favorable conditions. Three to 10 very small flowers are borne on an umbel that is always shorter than the leaves. The fruits are globose, 0.06-0.08 inch in diameter, and usually slightly longer than wide (Affolter 1985). The species reproduces sexually through flowering and asexually from rhizomes, the latter probably being the primary reproductive mode. An additional dispersal opportunity occurs as a result of the dislodging of clumps of plants which then may reroot in a different site along aquatic systems.

Huachuca water umbel was first described by A.W. Hill based on the type specimen collected near Tucson in 1881 (Hill 1926). Hill applied the name *Lilaeopsis recurva* to the specimen, and the name prevailed until Affolter (1985) revised the genus. Affolter applied the name *L. schaffneriana* ssp. *recurva* to plants found in Arizona; while plants from Mexico and northern South America were referred to as *L. s. ssp. schaffneriana*.

Huachuca water umbel has been documented from 26 sites in Santa Cruz, Cochise, and Pima counties, Arizona, and in adjacent Sonora, Mexico, west of the continental divide (Haas and Frye 1997, Saucedo 1990, Warren *et al.* 1989, Warren *et al.* 1991, Warren and Reichenbacher 1991, Service files). The plant has been extirpated from six of the 26 sites. The 20 extant sites occur in four major watersheds - San Pedro River, Santa Cruz River, Rio Yaqui, and Rio Sonora. All sites are between 3,500 to 6,500 ft elevation.

Huachuca water umbel has an opportunistic strategy that ensures its survival in healthy riverine systems, cienegas, and springs. In upper watersheds that generally do not experience scouring floods, the umbel occurs in microsites where interspecific plant competition is low. At these sites, the umbel occurs on wetted soils interspersed with other plants at low density, along the periphery of the wetted channel, or in small openings in the understory. The upper Santa Cruz River and associated springs in the San Rafael Valley, where a population of Huachuca water umbel occurs, is an example of a site that meets these conditions. The types of microsites required by the umbel were generally lost from the main stems of the San Pedro and Santa Cruz rivers when channel entrenchment occurred in the late 1800's. Habitat on the upper San

Pedro River is recovering, and Huachuca water umbel has recently been found along short reaches of the main channel.

In stream and river habitats, Huachuca water umbel can occur in backwaters, side channels, and nearby springs. After a flood, it can rapidly expand its population and occupy disturbed habitat until interspecific competition exceeds its tolerance. This response was recorded at Sonoita Creek in August 1988, when a scouring flood removed about 95 percent of the Huachuca water umbel population (Gori *et al.* 1990). One year later, the umbel had recolonized the stream and was again codominant with watercress, *Rorippa nasturtium-aquaticum* (Warren *et al.* 1991). The expansion and contraction of Huachuca water umbel populations appears to depend on the presence of "refugia" where the species can escape the effects of scouring floods, a watershed that has an unaltered hydrograph, and a healthy riparian community that stabilizes the channel.

Density of umbel plants and size of populations fluctuate in response to both flood cycles and site characteristics. Some sites, such as Black Draw, have a few sparsely-distributed clones, possibly due to the dense shade of the even-aged overstory of trees, dense nonnative herbaceous layer beneath the canopy, and deeply entrenched channel. The Sonoita Creek population occupies 14.5 percent of a 5,385 square foot patch of habitat (Gori *et al.* 1990). Some populations are as small as 11-22 square feet. The Scotia Canyon population, by contrast, has dense mats of leaves. Scotia Canyon contains one of the larger Huachuca water umbel populations, where in 1995 it occupied about 64 percent of a 1,420 m (4,660 foot) reach (Falk 1998).

While the extent of occupied habitat can be estimated, the number of individuals in each population is difficult to determine because of the intermeshing nature of the creeping rhizomes and the predominantly asexual mode of reproduction. A "population" of Huachuca water umbel may be composed of one or many genetically distinct individuals.

Overgrazing, mining, hay harvesting, timber harvest, fire suppression, and other activities in the nineteenth century led to widespread erosion and channel entrenchment in southeastern Arizona streams and cienegas when above-average precipitation and flooding occurred in the late 1800's (Bahre 1991, Bryan 1925, Dobyns 1981, Hastings and Turner 1980, Hendrickson and Minckley 1984, Martin 1975, Sheridan 1986, Webb and Betancourt 1992). A major earthquake near Batepito, Sonora, approximately 40 miles south of the upper San Pedro Valley, resulted in land fissures, changes in groundwater elevation and spring flow, and may have preconditioned the San Pedro River channel for rapid flood-induced entrenchment (Hereford 1993, Geraghty and Miller, Inc. 1995). These events contributed to long-term or permanent degradation and loss of cienega and riparian habitat on the San Pedro River and

throughout southern Arizona and northern Mexico. Much habitat of the Huachuca water umbel and other cienega-dependent species was presumably lost at that time.

Wetland degradation and loss continues today. Human activities such as groundwater overdrafts, surface water diversions, impoundments, channelization, improper livestock grazing, chaining, agriculture, mining, sand and gravel operations, road building, nonnative species introductions, urbanization, wood cutting, and recreation all contribute to riparian and cienega habitat loss and degradation in southern Arizona. The local and regional effects of these activities are expected to increase with the increasing human population.

Dredging extirpated the Huachuca water umbel from House Pond, near the extant population in Black Draw (Warren *et al.* 1991). The umbel population at Zinn Pond in St. David near the San Pedro River was probably lost when the pond was dredged and deepened. This population was last documented in 1953 (Warren *et al.* 1991).

Livestock grazing can affect the umbel through trampling and changes in stream hydrology and loss of stream bank stability. However, existence of the umbel appears to be compatible with well-managed livestock grazing (Service 1997a). In overgrazed areas, stream headcutting can threaten cienegas where the umbel occurs. Such headcutting occurs at Black Draw just south of the international boundary and at Los Fresnos, in the San Rafael Valley, Sonora. Groundwater pumping has eliminated habitat in the Santa Cruz River north of Tubac, and threatens habitat in the San Pedro River. Severe recreational impacts in unmanaged areas can compact soils, destabilize stream banks, and decrease riparian plant density, including densities of the Huachuca water umbel. Populations in Bear Canyon in the Huachuca Mountains have been impacted by trampling and off-highway vehicles.

A suite of nonnative plant species has invaded wetland habitats in southern Arizona (Stromberg and Chew 1997), including those occupied by the Huachuca water umbel [Arizona Department of Water Resources (ADWR) 1994]. In some cases their effect on the umbel is unclear. However, in certain microsites, the nonnative Bermuda grass, *Cynodon dactylon*, may directly compete with the umbel. Bermuda grass forms a thick sod in which many native plants are unable to establish. Watercress is another nonnative plant now abundant along perennial streams in Arizona. It is successful in disturbed areas and can form dense monocultures that can outcompete Huachuca water umbel populations.

Limited numbers of populations and the small size of populations make the Huachuca water umbel vulnerable to extinction as a result of stochastic events that are often exacerbated by habitat disturbance. For instance, the restriction of this taxon to a relatively small area in southeastern Arizona and adjacent Sonora increases the chance that a single environmental catastrophe, such as a severe tropical storm or drought, could eliminate populations or cause

extinction. Populations are in most cases isolated, as well, which makes the chance of natural recolonization after extirpation less likely. Small populations are also subject to demographic and genetic stochasticity, which increases the probability of population extirpation (Shafer 1990, Wilcox and Murphy 1985).

ENVIRONMENTAL BASELINE

At and in the vicinity of Fort Huachuca, extant *Lilaeopsis* populations occur on the San Pedro River on lands managed by the Bureau of Land Management (BLM), in canyons of the Huachuca Mountains on the Fort, and on lands managed by the Coronado National Forest or owned by private individuals. Two extirpated populations in the upper San Pedro watershed occurred at Zinn Pond in St. David and the San Pedro River near St. David.

San Pedro River Localities of the Huachuca Water Umbel

The upper San Pedro River is characterized by a relatively broad floodplain that meanders through the San Pedro River Valley. The riparian zone consists of cottonwood-willow and herbaceous associations near the river channel, to mesquite bosque on the higher terraces. Pond and marshland communities, saltcedar, *Tamarix chinensis*, four-wing saltbush, *Atriplex canescens*, and sacaton, *Sporobolus* spp., associations also exist in the riparian zone of the river. The upper San Pedro River is perennial from approximately Hereford to about four miles north of the Charleston Stream Gage. The Babocomari River, which drains portions of the Mustang, Huachuca, and Whetstone mountains, and the Canelo Hills, is the largest tributary and enters the San Pedro River just south of Fairbank. O'Donnel Creek, Ramsey Canyon, and Miller Canyon are other important tributaries [ASL Hydrologic and Environmental Services (ASL) 1994.] Hydrologists have divided the upper San Pedro River into two subwatersheds, including: 1) Sierra Vista subwatershed, which includes the river and its watershed from the international boundary north to a point approximately 3 miles north of Fairbank, and 2) Benson subwatershed, which includes the river and its watershed from the northern boundary of the Sierra Vista subwatershed north to the "Narrows" several miles north of Benson (ADWR 1991). Two major diversions of surface flow have occurred on the upper San Pedro River in the Benson subwatershed, including: 1) St. David ditch, located north of the Babocomari River and approximately 5 miles south of St. David, and 2) Pomerene Canal (ADWR 1994). All surface flow of the river up to 24 cfs is diverted into the St. David ditch for use by the St. David Irrigation District (ADWR 1991, Steve Lacey, Fluid Solutions, Phoenix, pers. comm. 1999). The perennial reach of the San Pedro River, as defined by ADWR (1991), ends at the St. David diversion. This diversion is just inside the northern boundary of the San Pedro Riparian National Conservation Area (RNCA). The current status of the Pomerene Canal diversion is unknown.

The San Pedro River RNCA was designated in 1988 as part of the Arizona-Idaho Conservation Act. The RNCA, which is managed by the BLM, includes roughly 57,000 acres in a strip approximately 36 miles long and 2.6 miles wide that runs from the international boundary north to about 3 miles south of St. David (but there is an approximate two mile gap in the RNCA just north of Palominas and a section just north of Lewis Springs.) The purposes of the RNCA as defined in the legislation are to conserve, protect, and enhance the riparian area and the aquatic, wildlife, archeological, paleontological, scientific, cultural, educational, and recreational resources of the area. The legislation established a Federal reserve water right adequate to fulfill the purposes of the RNCA. The riparian corridor through the RNCA is one of the most extensive, contiguous reaches of cottonwood-willow gallery forests in the southwestern United States (BLM 1998).

The Huachuca water umbel was located on the San Pedro River RNCA in 1994. Mark Fredlake (BLM, Sierra Vista, AZ), Peter Warren and Dave Gori (The Nature Conservancy, Tucson, AZ) located 43 patches of Huachuca water umbel during 1995 and 1996. Haas and Frye (1997) identified eight additional patches in 1997. These patches were found in six disjunct areas, including approximately 2 miles downstream of Fairbank, near Brunchow Hill upstream of Charleston, in the river at Lewis Springs, approximately one mile north and south of Highway 90, approximately 2.5 miles downstream of Highway 90, and from Hereford Bridge north for approximately 1 mile. Haas and Frye (1997) also documented the species on the San Pedro River approximately 0.5 mile south of the international boundary.

The umbel is sensitive to flooding and populations may disappear while others become established during and after severe flood events. Two patches of Huachuca water umbel on the San Pedro River were lost during a winter flood in 1994 and had still not recolonized that area as of May of 1995, demonstrating the dynamic and often precarious nature of occurrences within a riparian system (Al Anderson, Grey Hawk Ranch, *in litt.* 1995). However, after high flows in 1996, no apparent loss or reduction in approximately 12 Huachuca water umbel patches were noted by Dr. Peter Warren (The Nature Conservancy, Tucson, pers. comm. 1997). The entire San Pedro RNCA is considered potential habitat for the Huachuca water umbel. It is the largest contiguous potential habitat of the umbel, and as such is considered the most important site for recovery.

Comparison of current conditions with accounts of explorers and others who visited the San Pedro River more than a century ago suggest that cienegas and wetlands have largely disappeared or have been replaced by riparian woodlands. When Padre Kino visited the San Pedro River in the late 1600's, he encountered an unincised marshy river where the native Sobaipuris people were living and irrigating several types of crops with water diverted from the river through canals (Kino 1919, Hendrickson and Minckley 1984). The Sobaipuris vacated the area after intense raiding by Apaches in 1762, leaving the valley to sporadic cattle operations run by Mexicans. The riverbottom was heavily stocked by cattle in the early part of

the 1800's, but ranches were abandoned due to Apache raids. Wild livestock left behind by the ranchers were abundant when explorers visited the San Pedro in the mid-1800s, but despite this grazing, the river in 1846 was described as a "marshy bottom with plenty of grass and water" (Cooke 1938), and was characterized by tall grasses that were difficult to pass through (Evans 1945, Cooke 1938). Boggy banks and swampy conditions were described by Eccleston (1950). Cottonwoods, willows, and other riparian trees were present (Leach 1858, Parke 1857), but most descriptions suggest they were less evident than today, and that cienega conditions prevailed (Hendrickson and Minckley 1984). This characterization is however, contrary to some descriptions from the period indicating the river was incised near St. David and Benson (Parke 1857, Bartlett 1854). Hendrickson and Minckley (1984) suggest entrenchment was local and discontinuous in the mid 1800's. The marshy, cienega conditions encountered by explorers in the 1800's were likely ideal habitats for the Huachuca water umbel.

A series of large floods resulted in channel entrenchment between 1880 and 1908 (Hereford 1993), and possibly as late as 1926 (Jackson *et al.* 1987). Flooding and downcutting left the river channel 3-30 feet below the former floodplain (Hereford 1993), which would have left most of the marshy bottomlands, and the habitat of the water umbel, high and dry. Completion of two cross-continental railways across Arizona in the 1880's, military conquest of the Chiricahua Apaches, and discovery of extensive silver deposits near Tombstone in the late 1870's spurred a boom in the mining and livestock industries and facilitated settlement and development of the area (Rogers 1965, Sheridan and Hadley 1994). Watershed degradation caused by extensive mining, wood cutting, and heavy grazing exacerbated the effects of unusually heavy rainfall, resulting in entrenchment of the river channel and loss of cienega habitats (Hereford 1993, ADWR 1994, Jackson *et al.* 1987, Geraghty and Miller, Inc. 1995). Other factors that affected the distribution and abundance of cienega conditions on the San Pedro River include elimination of beavers and a major earthquake (San Pedro Expert Study Team 1999, DuBois and Smith 1980, Geraghty and Miller, Inc. 1995). Through construction of dams, beaver, *Castor canadensis*, probably contributed to the abundance of marshy, boggy conditions on the San Pedro River observed by explorers prior to entrenchment. However, as a result of overharvest, beaver were eliminated from the upper San Pedro, possibly near the turn of the century (Fredlake 1996). Following a major earthquake in 1887, the epicenter of which was located approximately 40 miles south of the upper San Pedro Valley, cienegas near St. David dried up, while in other areas artesian flows developed. The earthquake may have contributed to conditions that lead to channel entrenchment (Geraghty and Miller, Inc. 1995, Hereford 1993). With resulting loss of cienega conditions, the Huachuca water umbel probably became extremely limited in distribution or disappeared from the San Pedro River at this time. It was collected from the San Pedro River in 1958 (Warren *et al.* 1989), which may have represented a remnant population.

Since entrenchment during 1880-1926, the river channel has widened substantially, peak flows have declined, sinuosity of the channel has increased, and riparian woodlands have developed

on the floodplains (Hereford 1993). Hereford (1993) suggests that "increased sinuosity produced a reservoir effect that attenuated flood waves, and the development of floodplains enabled flood waters to spread laterally, thereby increasing transmission losses."

Improvements in watershed condition and resulting increased infiltration and reduced runoff may have also contributed to reduced peak flows.

Few direct human impacts to umbel habitat in the San Pedro River have occurred since establishment of the RNCA. However, recreation and associated impacts are becoming increasingly evident. A wildfire just north of the Highway 90 bridge destroyed 780 acres of riparian woodlands and grasslands in late May and June 1998. The cause of the fire is unknown, but recreational activities are likely to increase the incidence of fire in the future. Recreation may be adversely affecting the umbel through trampling and bank erosion in some areas, particularly at the Highway 90 locality. Another fire, apparently caused by a downed power line, burned approximately 800 acres in the RNCA in March 1999. Removal of most livestock after establishment of the RNCA stimulated a recovery of riparian and wetland plant communities. Trespass cattle along the river were causing localized trampling of water umbel sites near the Highway 90 crossing in 1997, and continue to be a problem in some areas of the RNCA, but the BLM has stepped up efforts to control trespass cattle. The immediate watershed of the upper San Pedro River continues to be degraded to some extent by livestock grazing. Disturbance of soils and cryptobiotic crusts, and removal of vegetation in the watershed by grazing combine to increase surface runoff and sediment transport, and decrease infiltration of precipitation (Belsky and Blumenthal 1997, Busby and Gifford 1981, DeBano and Schmidt 1989, Belnap 1992, Gifford and Hawkins 1979, Blackburn 1984). Degraded watershed condition due to grazing is particularly evident along Highway 90 north of Huachuca City where grasses have been largely eliminated. Between 1974 and 1987, grassland communities in the upper San Pedro basin decreased in cover by 35 percent (U.S. Environmental Protection Agency 1997) and have been replaced by desert scrub communities.

As mentioned above, the beaver was eliminated from the upper San Pedro River basin probably circa 1900. The BLM and Arizona Game and Fish Department recently reintroduced several beaver into the RNCA between the Hereford Bridge and the Highway 90 bridge. The effects of reintroducing beaver into the river system were the subject of recent formal section 7 consultation between the Service and BLM. In the biological opinion, the Service found that proposed reintroduction would not jeopardize the continued existence of the Huachuca water umbel. Beaver could facilitate reestablishment of cienega conditions through construction of dams and ponding of water. Effects on existing individual plants or populations of plants cannot be determined and would depend on the location and extent of beaver activity and the level of success of the beaver reintroduction program.

The greatest threat to umbel habitat on the San Pedro River is continued groundwater pumping in excess of recharge, which has the potential to lower groundwater elevation under portions of

the river, eliminate base flows, and result in dessication of the riparian and wetland vegetation communities (BLM 1998, Stromberg *et al.* 1996, ADWR 1994.) The hydrology of the upper San Pedro Basin and associated topics have been studied by numerous investigators, particularly in the last decade (i.e. Coes *et al.* 1999, Goodrich *et al.* 1998, Koehler and Ball 1998, MacNish 1998, Pool *et al.* 1998, Sharma *et al.* 1997; Wynn and Gettings 1997, Corell *et al.* 1996, Corell 1996, Stromberg *et al.* 1996, Water and Environmental Systems Technology, Inc. 1994, 1996, ASL 1994, 1995, 1998, Lacher 1994, Hereford 1993, Braun *et al.* 1992, Vionnet and Maddock 1992, ADWR 1991, 1994, Putman *et al.* 1988, Jackson *et al.* 1987, Freethy 1982, Arizona Water Commission 1974). Much of the recent work has been driven by a water rights adjudication in the Gila River basin, which includes the upper San Pedro River; and concerns that groundwater pumping in the Sierra Vista subwatershed may result in declining groundwater elevations and loss of baseflow and riparian values along the San Pedro River.

Hydrology of the Upper San Pedro River Basin:

River Flow and Trends

Flows in the upper San Pedro River are considered intermittent from the Mexican boundary to about four miles north of Palominas. The river is mostly perennial through the RNCA to about four miles north of the Charleston Stream Gage, after which it is intermittent (ASL 1994). Table 2 presents median monthly stream flows at the three gaging stations maintained by US Geological Survey, including the Palominas Gage (T23S R22E, S33), the Charleston Gage (T21S, R21E, S11), and the Tombstone Gage (T19S, R21E, S28). The greatest discharges are often recorded at the Tombstone Gage, although this is a "losing reach" (the river loses water to the floodplain aquifer) (Jackson *et al.* 1987, ASL 1994). Flows at the Tombstone Gage are bolstered by inflows from the Babocomari River, which flows during and after precipitation events, but contributes little to baseflow (ASL 1994). Flows largely correspond to precipitation in the watershed; and are lowest in May, June, and early July during the dry season, and are greatest during the summer monsoons in mid to late July and August or in winter.

Jackson *et al.* (1987) evaluated trends in flows at the Charleston Gage during 1931-1985. Mean annual flows showed no significant trends over time, however, peak flows and mean annual low flows (lowest flow during any 1, 7, 30, and 90 day periods in a year) declined significantly. A similar significant declining trend in low flows was noted at the Palominas Gage. Geraghty and Miller, Inc. (1995) found that low flows at Charleston decreased substantially from 1905 to 1928, then increased until 1930. After 1930, the authors found that low flows generally declined. Koehler and Ball (1998) found that annual 7-day low flows at Charleston declined an average of 0.04 ± 0.01 cfs per year from 1935 to 1996. Winter baseflows at Charleston declined steadily prior to 1951, but since then no trends were

Table 2: Median monthly stream flow [cubic feet per second (cfs)], San Pedro River, Sierra Vista Subwatershed, 1931-1983 (from Jackson *et al.* 1987)

Month	Gaging Station		
	Palominas	Charleston	Tombstone
January	10.9	23.5	35.8
February	8.6	20.3	32.1
March	6.3	18.9	29.1
April	2.5	12.2	15.7
May	1.2	7.9	1.4
June	0.6	4.2	3.0
July	15.7	29.1	67.2
August	51.9	91.6	18.4
September	10.7	24.2	18.4
October	3.7	12.2	13.0
November	3.6	13.6	12.2
December	5.5	17.1	20.2

detected; winter baseflow correlates somewhat with meteorological events (Pool *et al.* 1998, Koehler and Ball 1998). Interpretations of trends at Charleston before 1942 are questionable because the gage was at various locations in a six mile reach before 1942 (Robert MacNish, University of Arizona, Tucson, AZ, pers. comm. 1998).

Analysis by Corell *et al.* (1996) demonstrate that baseflow at Charleston declined from 9,470 acre-feet per year in 1940 to 6,332 acre-feet per year in 1951. Baseflow declined again at Charleston from 6,583 acre-feet per year in 1973 to 4,750 acre-feet per year in 1981. Jackson *et al.* (1987) note that at the Palominas Gage, "since 1950 it is common to have zero flow for both the 1-day and 7-day periods, and not uncommon to have zero flow for the 30-day period." Although none of the upper San Pedro River gages are considered accurate to within 15 percent for low flows, and as noted, analysis of trends at Charleston before 1942 is suspect, the overall declining trends in annual low flow are highly significant statistically (Jackson *et al.* 1987, Koehler and Ball 1998). These trends are difficult to explain by fluctuations in precipitation alone (Koehler and Ball 1998, Pool *et al.* 1998, Jackson *et al.* 1987). Possible causes include: 1) changes in runoff from the watershed due to changes in watershed condition,

2) influences of near-stream groundwater pumping for agricultural purposes, 3) changes in water use in Mexico, 4) changes in water consumption by riparian vegetation along the river, and 5) groundwater pumping from the regional aquifer (ASL 1994, Jackson *et al.* 1987). Koehler and Ball (1998) conclude that there is little doubt that annual 7-day low flows are declining, but that evidence is lacking for a non-seasonal aquifer-wide phenomenon (such as groundwater pumping from the regional aquifer) being the sole cause of the decline. There is some preliminary evidence that low summer precipitation over the last 10-20 years has reduced recharge adjacent to the river and may have contributed to observed reduced baseflow (Don Pool, USGS, Tucson, pers. comm. 1999). Robert MacNish (pers. comm. 1998) notes that a diversion in Mexico, constructed in 1946-48, may be responsible for an approximate 0.5 cfs decline in baseflow (approximately 25 percent of the drop in baseflow at Charleston between 1942 and 1996).

Geraghty and Miller, Inc. (1995) found that declining flows since 1930 correlate well with the development of riparian woodlands, and that resulting increased evapotranspiration probably exacerbated seasonal and long-term declines in baseflow. The riparian vegetation along the San Pedro River is the largest single consumer of groundwater in the subwatershed (San Pedro Expert Study Team 1999). Some have suggested that vegetation along the San Pedro River may need to be "managed" to prevent reductions or loss of baseflow. However, the assumption that water use by riparian vegetation may reduce or eliminate baseflow ignores other hydrological benefits of riparian vegetation, including reducing flow velocity during flood events, thus facilitating capture of sediments and increased recharge of flood waters, reduced downcutting and incisement of the channel and associated draining of bank storage, and addition of woody debris to the river channel, which also slows flow velocity and allows greater recharge (DeBano *et al.* 1995). Also, attempts to increase stream flow or to salvage water by eliminating or reducing riparian vegetation have failed or were only marginally successful (see review in DeLoach 1991). For instance, eradication of saltcedar from 21,500 acres of the Pecos River in New Mexico has resulted in no detectable increase in river baseflow (DeLoach 1991). Furthermore, "management" or removal of riparian vegetation could have adverse effects on the water umbel, the southwestern willow flycatcher, and other species, and may be contrary to the Congressionally-designated purposes of the Riparian National Conservation Area.

The BLM established nine stream gages on the San Pedro River and one gage on the Babocomari River in the RNCA in 1987. Sharma *et al.* (1997) evaluated data from these gages, and correlations between these gages and the USGS gage at Charleston. Key findings from this report in regard to surface flows in the river included: 1) at low flows, the percentage of flow contributed by ground water discharge in the reach below Hereford has increased, possibly because of retirement of irrigated agriculture in the area, or as a result of diminished flows reaching Hereford from upstream; 2) there is a trend toward low flows becoming a greater percentage of daily discharge at Hereford - for instance, the number of days for which the flow was below 0.1 cfs was zero from 1987-1994, but from January-

September 1995 the number of days below 0.1 cfs was seven; 3) inflows below Lewis Springs are diminished as a percentage of flow at the Charleston Gage, possibly as a result of increased water use by phreatophytes or pumping outside of the RNCA; 4) low flows are becoming increasingly frequent at the Charleston Bridge based on observed trends during 1987-1994; 5) flows at Charleston Hills have remained similar to discharge at Charleston Bridge during 1987-1994; there is evidence that there may be a slight reduction in percentage of flow lost to the groundwater system in this reach; and 6) at Fairbank, the loss of streamflow to the groundwater system has decreased, possibly due to less consumption by phreatophytes, but low flows are increasingly common at this gage. Sharma *et al.* (1997) believed that the most likely cause of apparent decreased contribution of groundwater to stream flow in the Lewis Springs-Charleston Bridge reach was groundwater pumping outside of the RNCA.

In a draft report, MacNish (1998) evaluated the effects of possible changes in climate, inflows from Mexico, water use by riparian vegetation, and extraction of groundwater on baseflow. He concluded that climatic change, and reduced inflow from Mexico have had minor effects at most. Increased water use by riparian vegetation may be responsible for a little less than 25 percent of the observed decline in baseflow at Charleston. As noted earlier, MacNish (pers. comm. 1998) notes that a diversion in Mexico, constructed in 1946-48, may be responsible for an approximate 0.5 cfs decline in baseflow (approximately 25 percent of the drop in baseflow at Charleston between 1942 and 1996). However, MacNish (1998) concludes that the most important cause of diminished baseflow is groundwater pumping, particularly in the southern portion of the basin where groundwater pumping was closer to the river, and that groundwater pumping in the Fort Huachuca/Sierra Vista area began impacting river baseflow about 1990.

The San Pedro Expert Study Team (1999) assessed effects of groundwater pumping on riparian habitats and migratory birds. They found that modeling of the groundwater system in the basin suggests the cone of depression in the Fort Huachuca/Sierra Vista area began to have significant effects on discharge to the river in the 1960s or 1970s. The model used by the authors indicated that after 30 years of pumping, discharge to the river was reduced to 30 percent of what it was before pumping. After 50-60 years of pumping the gradient to the river becomes flat and there is no longer flow to the river. If trends continue, gaining reaches of the river would become losing reaches. However, as groundwater elevation drops, riparian vegetation would decline resulting in less evapotranspiration, thus somewhat mitigating groundwater withdrawals. The authors do not state the model's baseline for when groundwater pumping started. Groundwater pumping was occurring in 1940, but significant withdrawals did not occur until the early 1960's (Vionnet and Maddock 1992). If the authors meant that groundwater pumping began in 1940, then 50-60 years after initiation of pumping would be 1990-2000. If initiation was in the early 1960's, then 50-60 years thereafter would be 2010-2020.

Groundwater pumping and land uses upstream of the RNCA in Mexico affect flows as well. The best information available indicates that approximately 3,200 acres of farmland are irrigated in the Mexican portion of the San Pedro River basin (Watts *et al.* 1998). An estimated 9,600 acre feet of water is used per year to irrigate these croplands. If this pumping were eliminated, median flows at Palominas would increase roughly by five cfs [3,500 acre feet per year (San Pedro Expert Study Team 1999)]. An increase of 3,500 acre feet would represent approximately an 18 percent increase in annual groundwater supplies in the Sierra Vista subwatershed. An estimated 2,300 acre feet per year is pumped for domestic uses in Cananea, Naco, and other smaller settlements. Pumping also occurs to support mining and a smelter at Cananea, but this pumping occurs on the southern edge of the watershed and may not impact baseflows of the San Pedro River in the United States significantly (San Pedro Expert Study Team 1999).

The conclusions of the San Pedro Expert Study Team (1999), MacNish (1998), and Sharma *et al.* (1997) that groundwater pumping in the Fort Huachuca/Sierra Vista area has affected baseflow have been questioned by some hydrologists. In a May 28, 1997, letter to Michael Shaughnessey, Fort Huachuca, hydrologist Jon Fenske, Army Corps of Engineers, believed the finding by Sharma *et al.* (1997) that groundwater pumping caused the observed changes in flow in the Lewis Springs-Charleston Bridge reach was "premature and unsupported by physical evidence and justification." In a July 1, 1998, memorandum (Fenske 1998), Mr. Fenske presented monitoring well data suggesting that from April 1995 to April 1998 the groundwater gradient along a transect from Sierra Vista to the San Pedro River at Charleston was reversed only within about 3.5 miles of Sierra Vista (i.e. the cone of depression had not reached the river in this area). However, in a letter to Mike Shaughnessey, Fort Huachuca, Mr. Fenske stated that several more years of data collection are needed to make conclusive statements based on the well data. In a June 6, 1997, letter to Dennis Sundie, ADWR, about the findings in Sharma *et al.* (1997), Frank Putman, ADWR, stated "it seems inappropriate to assert that changes seen in stream flow are due to pumping, phreatophyte growth, agricultural use, or climatic factors without an in-depth examination of these factors, which this report does not do."

Summary of Groundwater Data

Groundwater elevation contour maps have been constructed for the Sierra Vista subwatershed from well data. These maps illustrate that groundwater enters the watershed in the form of mountain-front recharge, from the San Pedro River in losing reaches, and as groundwater flow moving northward from Mexico. Groundwater is lost to the San Pedro River in gaining reaches, from evapotranspiration, groundwater pumping, and groundwater flow out of the basin to the north (ASL 1994). The aquifer is composed of a deep, regional aquifer that is mostly unconfined, except in some portions of the southern half of the subwatershed (ADWR 1994, Wynn and Gettings 1997). The regional aquifer may contain an estimated 31.8 million

acre-feet of recoverable water in storage to a depth of 1,200 feet (ADWR 1991), although a recent draft report suggests the storage may be less due to the presence of extensive clay deposits (Wynn and Gettings 1997; Mark Gettings and Don Pool, US Geological Survey, Tucson, AZ, pers. comm. 1998-1999). The floodplain aquifer is long, narrow, relatively shallow, and lies along the San Pedro River. Estimated water in storage on the floodplain aquifer is 160,000 acre-feet to a depth of 60 feet (ADWR 1991). Groundwater elevation in the floodplain aquifer is closely associated with river flow.

Based on a 1990 water budget modeling effort conducted by ADWR (1991), annual water supply into the Sierra Vista subwatershed was estimated at 56,820 acre-feet. Approximately 28,850 acre-feet were withdrawn for consumptive use, while 39,200 acre-feet flowed out of the system as surface flow in the San Pedro River. Major contributions to "consumptive use" included water use by phreatophytes (~50 percent), irrigation (~16 percent), and municipal and military (~23 percent). The modeling demonstrated that use exceeded recharge by roughly 11,230 acre-feet per year, which is the amount that is lost in storage each year (ASL 1994). A reevaluation of the water budget shows the deficit is currently roughly 7,000 acre-feet per year (San Pedro Expert Study Team 1999, Corell *et al.* 1996). The reduction in the deficit is due primarily to retirement of agricultural pumping. An estimated 500-900 acres of irrigated agriculture still remains in the subwatershed, which is responsible for approximately 1,500-2,800 acre-feet of water use per year (San Pedro Expert Study Team 1999).

Groundwater pumping in excess of recharge has created local declines in groundwater elevation at Fort Huachuca/Sierra Vista and at Hereford/Palominas. "Cone(s) of depression" in the vicinity of Fort Huachuca and Sierra Vista encompasses approximately 7.5 square miles running in a northwest-southeast direction, paralleling the Huachuca Mountains for at least 15 miles from approximately the Babocomari River to south of Sierra Vista (ADWR 1994, Wynn and Gettings 1997, Schwartzman 1990).

Groundwater elevations have declined 20-90 feet in the Fort Huachuca/Sierra Vista cone of depression (Corell *et al.* 1996). Groundwater levels declined approximately 1.4 feet per year in this area from 1966-1986 (Putnam *et al.* 1988). Groundwater pumping at the north end of the cone of depression has affected flow patterns of the Babocomari River in the vicinity of northern Huachuca City and the Fort Huachuca East Range, where baseflow is severely depleted or absent during the pre-monsoon dry season (Schwartzman 1990). Current groundwater drawdown along the Babocomari River is attributed to pumping by Huachuca City, Fort Huachuca, and City of Sierra Vista. Modeling predicts that pumping by Fort Huachuca and Sierra Vista will be responsible for 84-91 percent of the drawdown by 2015 (Schwartzman 1990). Another cone of depression in the Hereford-Palominas area is not as deep, but it underlies the San Pedro River and thus directly affects river flow. However, recent retirement of agricultural pumping in the area has apparently allowed or contributed to some recovery of groundwater elevation (Sharma *et al.* 1997).

Most investigators do not believe the Fort Huachuca/Sierra Vista cone of depression has "reached" the San Pedro River (Fenske 1998, ASL 1995, ADWR 1994, 1991); however, the cone of depression captures water that would have reached the San Pedro River in pre-development conditions (Corell *et al.* 1996, ADWR 1991). The cone of depression may not actually need to contact the river or reverse the flow of groundwater at the river (cause portions of the river to become losing reaches) to significantly affect baseflow. The cone of depression will decrease the hydraulic head adjacent to the river before it reverses the flow of groundwater. However, there is uncertainty as to how much of the currently observed decline in baseflow can be attributed to the reduced hydraulic head caused by the Fort Huachuca/Sierra Vista cone of depression (Koehler and Ball 1998). Modeling by Water and Environmental Systems Technology, Inc. (1996) estimated that agricultural users were responsible for 94 percent of the historic loss of river flow through 1988, while municipal and military users were only responsible for six percent. However, the authors did not calculate such estimates for present or future conditions. The San Pedro Expert Study Team (1999) believe river flow was affected by the Fort Huachuca/Sierra Vista cone of depression as early as the 1960s or 1970s. MacNish (1998) believes the Fort Huachuca/Sierra Vista cone of depression began affecting baseflow about 1990, but that current declines are due primarily to pumping (mostly agricultural) in the Hereford/Palominas area. He believes that without mitigation, it is likely that the perennial reach of the San Pedro River north of Lewis Springs will become intermittent, if not ephemeral (lacking in baseflow), perhaps within a decade.

Clay deposits occur in the San Pedro River Valley near Palominas and St. David. Recent information developed by Don Pool and his colleagues at USGS indicates clay deposits also occur along the west side of the river downslope from Sierra Vista that run in a north-south direction. The extent of the clay deposit is unknown, but the eastern edge of the deposit intersects the river at about one to two miles south of Highway 90 (D. Pool, pers. comm. 1999, San Pedro Expert Study Team 1999). The location of the deposit suggests the reach in the vicinity of the Babocomari confluence would likely be the first area affected by groundwater pumping at Fort Huachuca and Sierra Vista, followed by the reach north of Charleston, and then the reach from Highway 90 to Charleston (Don Pool, pers. comm. 1999). Although the hydraulic conductivity is low in the area of the deposit, Don Pool does not believe the clay deposit would slow the spread of the cone of depression or effects to river baseflow. Of particular concern are wells that draw water from below the clay deposit, which would have the greatest potential to affect river baseflow. Dr. Mark Gettings (pers. comm., USGS, Tucson, 1998) has stated that the presence of an "intermediate conductor" (clay deposit) would not prevent the cone of depression from spreading eastward to the San Pedro River. He said that a clay layer may slow the spread of the cone, but depending on the nature of underlying substrates, a siphon effect under the clay layer could cause the cone of depression to spread very rapidly to the east. The deposit also limits the size of the groundwater reservoir, which could also speed enlargement of the cone of depression. South of Highway 90, the river probably flows, at least in part, atop the clay deposit, and flows probably reflect recharge near the river or inflow from upstream. In this reach, changes in the regional

aquifer, such as groundwater pumping at Fort Huachuca and Sierra Vista, are less likely to affect baseflow (Don Pool, pers. comm. 1999).

Summary of Predictive Modeling

Modeling of groundwater relationships in the San Pedro basin began in the early 1970s with the development of a groundwater flow model by the Arizona Water Commission (1974). Recent modeling has been conducted by ADWR (Putman *et al.* 1988, ADWR 1994, Corell 1996, Corell *et al.* 1996), University of Arizona (Braun *et al.* 1992, Vionett and Maddock 1992, Water Resources Research Center 1991), Water and Environmental Systems Technology, Inc. (1994, 1996), Schwartzman (1990), and ASL (1995, 1998). Some reports model historic conditions (transient models); while others predict future conditions. Models developed by ADWR and the University of Arizona build on a model developed by USGS (Freethy 1982). The ASL modeling efforts were developed specifically to evaluate the effects of various effluent recharge scenarios on groundwater hydrology and river flow. These models provide the basis for predicting the effects of groundwater pumping on flows in the San Pedro River, or in the Babocomari River (Schwartzman 1990), under varying future scenarios, such as continued human population growth at current rates and patterns, elevated growth at Sierra Vista and Fort Huachuca, drought, holding population static, etc. The conclusions of recent modeling efforts in regard to effects on river flow or extent of riparian vegetation under varying scenarios are presented in Table 3.

Table 3 attempts to summarize the conclusions of predictive modeling efforts; however, many of these studies are comprehensive and detail many modeling outputs not presented here. To fully understand the mechanics, outputs, assumptions, and uncertainties of these models requires an in-depth review of each report. Such a review is beyond the scope of this opinion. Also, some of the models may need to be reviewed and revised in regard to new information about the presence of a clay deposit in the San Pedro River Valley. However, some generalizations and commonalities can be drawn from the results of these various modeling exercises. A continuation of current growth patterns in the subwatershed without implementation of new recharge, water conservation, or other measures to reduce water use or enhance recharge will result in declining flows and loss of riparian vegetation on the San Pedro River [see scenarios (3) of Water and Environmental Systems Technology, Inc (1994), scenarios (A) and (D) of Braun *et al.* (1992), scenario (0) of ASL (1998) - Table 3].

Authors disagree as to when flows in the San Pedro may be significantly affected, but MacNish (1998) and the San Pedro Expert Study Team (1999) believe river flow has been affected for some time, while others believe flow may not be significantly affected for 40 years or more

Table 3: Summary of groundwater modeling efforts that predicted future river flow or extent of riparian vegetation

Source

Effects on Upper San Pedro River Flows or Riparian Vegetation

Scenario

<p>Water and Environmental Systems Technology, Inc (1994)</p> <p>This effort used the MODFLOW model with modifications by the authors. Outputs are annual average flows, which lump flood flows with baseflows. Flows are modelled from 1988-2088.</p>	
<p>(1) No pumping at the Fort/Sierra Vista after 1988, pumping in rural/agricultural areas at 1988 rates</p>	<p>Annual average flows decline at Charleston (42.7 cfs in 1988 to 41.5 cfs in 2088), at Fairbank (44.8 cfs in 1988, 43.6 cfs in 2088), at Benson Narrows (42.0 cfs in 1988 to 39.6 cfs in 2088)</p>
<p>(2) Very little pumping at the Fort/Sierra Vista, pumping in rural/agricultural areas at 1988 rates</p>	<p>Annual average flows decline at Charleston (42.7 cfs in 1988 to 40.9 cfs in 2088), at Fairbank (44.8 cfs in 1988, 43.0 in 2088), and at Benson Narrows (42.0 cfs in 1988 to 39.0 cfs in 2088)</p>
<p>(3) Same as 2nd scenario, but pumping in Fort/Sierra Vista area at 100 % of projected demand if no expansion of the Fort occurs</p>	<p>Annual average flow decline at Charleston (42.7 cfs in 1988 to 40.0 cfs in 2088), at Fairbank (44.8 cfs in 1988 to 42.1 cfs in 2088) and at Benson Narrows (42.0 cfs in 1988 to 38.1 cfs in 2088)</p>
<p>(4) Same as 2nd scenario but assumes a new command is established at the Fort</p>	<p>Annual average flows decline at Charleston (42.7 cfs in 1988 to 39.9 cfs in 2088), at Fairbank (44.8 cfs in 1988 to 41.9 cfs in 2088), and at Benson Narrows (42.0 cfs in 1988 to 37.9 cfs in 2088)</p>

(5) Same as 4 th scenario but assumes effluent	Annual average flows increase at Charleston (42.7 cfs in 1988 to 42.8 cfs in 2088), at Fairbank (44.8 cfs in 1988 to 44.9 in 2088), and at Benson Narrows flows decreased (42.0 cfs in 1988 to 40.8 cfs in 2088)
(6) Same as 5 th scenario, but pumping locations in the Sierra Vista area are spread over a larger area	Annual average flows increase at Charleston (42.7 in 1988 to 43.6 in 2088), at Fairbank (44.8 cfs in 1988 to 45.7 cfs in 2088), and at Benson Narrows flows decreased (42.0 cfs in 1988 to 41.6 in 2088)
(7) Same as 5 th scenario, but assumes greater effluent recharge	Annual average flows increased at Charleston (42.7 cfs in 1988 to 46.8 cfs in 2088), at Fairbank (44.8 cfs in 1988 to 49.0 cfs in 2088), and at Benson Narrows (42.0 cfs in 1988 to 44.7 cfs in 2088)
(8) Pumping in the Sierra Vista subwatershed increases at 3 % per year, no effluent recharge	Annual average flows decrease at Charleston (42.7 cfs in 1988 to 34.3 cfs in 2088), at Fairbank (44.8 cfs in 1988 to 36.3 cfs in 2088), and at Benson Narrows (42.0 cfs to 22.7 cfs in 2088)
(9) Same as scenario 8, but assumes effluent is recharged at the Sierra Vista water treatment plan, and recharge increases at 3 % per year	Annual average flow decrease at Charleston (42.7 cfs in 1988 to 36.3 cfs in 2088), and Fairbank (44.8 cfs in 1988 to 38.3 cfs in 2088), and at Benson Narrows (42.0 cfs in 1988 to 23.5 cfs in 2088)
Corell (1996): This modeling effort used the ADWR Sierra Vista subwatershed upper San Pedro Basin groundwater flow model. Population growth projections were provided by the Arizona Department of Economic Security. In scenarios with effluent recharge, recharge is assumed to occur at the Sierra Vista water treatment plant.	

<p>(0) Assumes no population growth in the Sierra Vista watershed after 1990, agricultural pumping in the Palominas/Hereford area is phased out by 2000, no effluent recharge</p>	<p>Stream flow (baseflow) increases at Palominas (1.13 cfs in 1990 to 2.2 cfs in 2030), at Charleston (4.81 cfs in 1990 to 5.74 cfs in 2030), and decreases at Tombstone gage (8.32 cfs in 1990 to 7.86 cfs in 2030), and on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.46 cfs in 2030).</p>
<p>(1.1) Assumes growth from current population of 51,400 to 73,870 in 2030, effluent recharge of 2,994 acre-feet/yr, agricultural pumping in the Palominas/Hereford area phased out by 2000.</p>	<p>Stream flow increases at Palominas (1.13 cfs in 1990 to 2.19 cfs in 2030), at Charleston (4.81 cfs in 1990 to 6.25 cfs in 2030), at Tombstone gage (8.32 cfs in 1990 to 8.46 cfs in 2030), and declines on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.47 cfs in 2030)</p>
<p>(1.2) same as 1.1, but assumes agricultural pumpage in Palominas/Hereford area at 1624 acre-feet/yr</p>	<p>Stream flow increases at Palominas (1.13 cfs in 1990 to 1.63 in 2030), decreases at Charleston (4.81 cfs in 1990 to 4.74 cfs in 2030), and decreases on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.47 cfs in 2030)</p>
<p>(2) Population increases to 68,330 in 2030, effluent recharge at 2,994 acre-feet/yr, agricultural pumping in the Hereford/Palominas area phased out by 2000</p>	<p>Stream flow increases at Palominas (1.13 cfs in 1990 to 2.19 cfs in 2030), at Charleston (4.81 cfs in 1990 to 6.25 cfs in 2030), and declines on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.47 cfs in 2030)</p>
<p>(3) Population increases to 77,724 in 2030, no effluent recharge, agricultural pumping in the Palominas/Hereford area phased out by 2000, evapotranspiration increases to 10,000 acre-feet/yr</p>	<p>Stream flow increases at Palominas (1.13 cfs in 1990 to 1.81 cfs in 2030), decreases at Charleston (4.81 cfs in 1990 to 4.56 cfs in 2030), at Tombstone gage (8.32 cfs in 1990 to 6.4 cfs in 2030), and on Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.35 cfs in 2030).</p>

<p>Braun <i>et al.</i> (1992): This modeling effort used the model "WATERBUD" developed by a team of hydrologists at the University of Arizona. The model has many outputs. Only scenarios examining simulated future changes in riparian acreage are summarized here.</p>	
<p>(A) Effects of water management in the Sierra Vista watershed are modeled in regard to effects on acreage of riparian vegetation. In scenario A, population growth patterns are assumed to remain static, and over 150 parameters are modeled at default settings, which approximate conditions in 1989-90. Under scenario A, various water management policies to curb use or enhance recharge are evaluated.</p>	<p>Increases in riparian acreage of up to 100 acres by 2010 occur under policies that result in increased river discharge and retirement of agricultural acreage. Such policies include enforcing a ceiling on domestic water consumption, requiring minimum irrigation efficiencies, retirement of irrigation water rights, and placing a pump tax on well withdrawals. Decreased riparian acreage of less than 100 acres by 2010 results from other policies, including maximal water conservation, and recharging effluent and cloud seeding. Without water policies, riparian acreage declines by approximately 60 acres.</p>
<p>(D) Population and agricultural water use are identical to scenario A, but this scenario assumes a worst case drought, which is the hottest and driest recorded in the previous 20 years.</p>	<p>Half of the policy scenarios result in decreased riparian acreage of approximately 100-250 acres, the other half result in modest gains of less than 50 acres by 2010. Policies leading to increased acreage include a pump tax and one variant of enforcing a ceiling on domestic water use, requiring minimum irrigation efficiencies, and allowing buy outs of irrigation water rights. Other variants of the latter, cloud seeding and effluent recharge, and maximal water conservation lead to declines in riparian acreage. Without these water policies, riparian acreage declines approximately 225 acres by 2010.</p>

<p>ASL Hydrologic & Environmental Services (1998): Using the model "MODFLOW", river baseflow is modeled through 2040 under three scenarios: no recharge, and "partial" and "full" recharge at the Sierra Vista wastewater treatment plant. All scenarios assume agriculture pumping at 1,624 acre feet/year, population growth based on latest estimates from AZ Department of Economic Security, and evapotranspiration remains at 1990 levels</p>	
<p>(0) No effluent recharge in Sierra Vista</p>	<p>Baseflow at Hereford remains near zero through 2040. At the Charleston Gage, river baseflow declines from 4.95 cfs in 1990 to 3.75 cfs in 2040. At Fairbank Gage, baseflow declines from 6.57 cfs in 1990 to 4.34 cfs in 2040. Declines begin by 2000. Baseflows decline from a point between Hereford and Lewis Springs downstream to at least Fairbank. Small increases in baseflow occur from the international boundary to near Hereford. Declines in baseflow begin by 2000.</p>
<p>(1) 1,516 acre-feet would be recharged per year from 2000-2010 and 1,762 acre-feet per year from 2010-2020. No recharge would occur after 2020.</p>	<p>Baseflow increases at Hereford remains near zero through 2040. At Charleston gage, baseflow declines from 4.95 cfs in 1990 to 4.00 cfs in 2040. At Fairbank Gage baseflow decreases from 6.57 cfs in 1990 to 4.64 cfs in 2040. Changes in flow begin by 2000. Baseflows decline from a point between Hereford and Lewis Springs downstream to at least Fairbank. Small increases in baseflow occur from the international boundary to near Hereford.</p>

<p>(2) Recharge rates would increase from 2,336 acre-feet in 2000-2010 to 3,647 acre feet in 2030-2040.</p>	<p>Baseflow at Hereford remains near zero from 2000-2040. At the Charleston Gage baseflow increases from 4.95 cfs in 1990 to 5.46 cfs in 2040. At Fairbank Gage, baseflow decreases from 6.57 cfs in 1990 to 6.13 cfs in 2040. Changes in flow begin by 2000. Small increases in baseflow occur from the international boundary to near Hereford and in the Lewis Springs-Charleston reach.</p>
<p>Schwartzman (1990)</p> <p>This study used the Theis equation to predict the effects of groundwater pumping on the Babocomari River. The model assumes that the regional aquifer is an isotropic homogeneous aquifer with an initially flat water table, infinite aerial extent, and no sinks or sources besides the pumping wells. The model assumes that the relative proportions of pumping between individual water users remains constant over the next 100 years. Pumping rates were based on existing conditions and remain constant throughout the 100-year period.</p>	
<p>Continuation of pumping at current rates in wells at Huachuca City (3 wells), Fort Huachuca (> 7 wells), and City of Sierra Vista (> 5 wells)</p>	<p>Groundwater declines in an area of considerable riparian vegetation downstream of Huachuca City by an estimated at 5.8 to 11.5 feet in 50 years and 8.6 to 20.5 feet in 100 years. Groundwater decline is attributable mostly to pumping by Fort Huachuca and City of Sierra Vista</p>

(ADWR 1991). The modeling efforts summarized in Table 3 estimate effects to the river as early as 2000 (Water and Environmental Systems Technology, Inc. 1994, ASL 1998); or 2010 (Braun *et al.* 1992). Drought would exacerbate the effects of groundwater pumping on baseflow (Braun *et al.* 1992) and there is some evidence that low summer precipitation over the last 10-20 years has reduced recharge adjacent to the river and may have contributed to reduced observed baseflow (Don Pool, pers. comm. 1999). Flow patterns on the Babocomari River have already been affected by groundwater pumping and declines are probably attributable to pumping by Huachuca City, Fort Huachuca, and City of Sierra Vista (Schwartzman 1990).

Interestingly, even if all groundwater pumping in the Sierra Vista/Fort Huachuca ceased and agricultural pumping rates were fixed at 1988 levels, modeling efforts showed that average annual flows would still decline at Charleston, Fairbank, and at Benson Narrows (Water and Environmental Systems Technology, Inc. 1994). This would occur because over time the cone of depression is expected to flatten out, even if the volume of the cone is decreasing. As it flattens out, it could capture the baseflow of the San Pedro River (C. Rovey, Water and Environmental Systems Technology, Inc., Denver, CO, pers. comm. 1995). This indicates that balancing water use and water supply may not be enough to prevent capture of river baseflow by the cone of depression. Effluent or other enhanced recharge adjacent to the river could perhaps establish a groundwater mound between the river and the pumping center and halt or slow the expansion of the cone of depression (ASL 1998). Temporarily pumping groundwater directly into the river may also mitigate effects of an expanding cone of depression, at least in the short term (San Pedro Expert Study Team 1999).

SAIC (1998a) maintains that studies and models that conclude that groundwater pumping in the Fort Huachuca area will, in time, result in reduced flows on the San Pedro River do not take into account recent findings of Wynn and Gettings (1997) and Don Pool. SAIC contends that these studies show the cone of depression is at least somewhat isolated from the San Pedro River, and therefore continued pumping from the cone in excess of recharge is less likely to affect the San Pedro River than suggested by earlier studies. As discussed above, this may be true for the reach from Hereford to Highway 90, where the clay deposit underlies portions of the river, but flows downstream of Highway 90, and particularly in the vicinity of the Babocomari confluence, are quite vulnerable to groundwater pumping at Fort Huachuca and Sierra Vista.

The modeling efforts summarized in Table 3 make it clear that several water management options are available that have great potential to mitigate or eliminate adverse effects on river flow and riparian vegetation, at least over the next 15-100 years. Recommendations for reducing the deficit in the water budget can be found in reports by the San Pedro Expert Study Team (1999), the Advisory Panel on the Upper San Pedro River (1998) (also see Commission for Environmental Cooperation 1999), the recommendations of a local consortium of water

users that was known as the Water Issues Group (WIG), recommendations of the Upper San Pedro Partnership, the draft Cochise County Comprehensive Plan, and the City of Sierra Vista's General Development Plan. One of the most effective means to reduce effects on the river is to retire agricultural pumping [compare scenarios 1.1 and 1.2 of Corell (1996), and see scenarios (A) and (D) of Braun *et al.* (1992)]. Modeling by Water and Environmental Systems Technology, Inc. (1996) estimates that agricultural users were responsible for 94 percent of the historic loss of river flow through 1988, while municipal and military users were only responsible for six percent. Retirement of agricultural pumping in the RNCA has resulted in apparent increases in groundwater discharge to the river below Hereford Bridge (Sharma *et al.* 1997) (although the increases are surprisingly small), and modeling suggests that cessation of agricultural pumping is one of the most important potential water management tools (Table 3). The San Pedro Expert Study Team (1999) found that 1,100 acre-feet could be saved per year by retiring the remaining 500-900 acres of irrigated agriculture in the subwatershed. Potential also exists for decreasing groundwater withdrawals by about 3,500 acre-feet annually if agricultural lands in Mexico were retired (San Pedro Expert Study Team 1999). A significant threat to the river is possible as a result of future development of new agriculture in the subwatershed or upstream in Mexico. Purchase of agricultural development rights, designation of an active management area (AMA) or irrigation non-expansion area under State law (which prohibit any new irrigation uses), or other mechanisms could be implemented to abate this threat.

Effluent recharge by the Fort, City of Sierra Vista, or others in the subwatershed could also be an important means to mitigate groundwater pumping, at least in the short term. In scenarios evaluated by ASL (1998), recharge of effluent at the City's wastewater treatment plant resulted in increased baseflow over the no recharge scenario in a reach from approximately Highway 90 downstream to at least Fairbank (Table 3). ASL's "partial recharge" scenario corresponds to a currently proposed project pursuant to a 1996 cooperative agreement among the City, Bureau of Reclamation, and the Arizona Water Protection Fund that calls for the City to recharge all of the effluent it owns and controls from 2000 through 2020. Under this scenario baseflow remains essentially the same from 2000 to 2020; whereas in the no recharge scenario, baseflow declines by as much as ~0.8 cfs between 2000 and 2020. Under the "full recharge" scenario, all effluent received at the wastewater treatment plant would be recharged through 2040, including all of the Pueblo Del Sol (a local developer and water company) effluent. This goes beyond the current proposal. However, under the "full recharge" scenario, baseflow increases over the year 2000 conditions in the reach from Lewis Springs to upstream of Charleston by as much as 0.5 cfs through 2040. Baseflows remain essentially unchanged in the Fairbank area (ASL 1998). The current proposal is underfunded by approximately \$1.8 million. Bureau of Reclamation and the City of Sierra Vista are in the process of developing an agreement for Reclamation to provide the additional needed funds.

Because of the importance of this project, an examination of the underlying assumptions of the model and the input variables is warranted to determine if the model output may provide a

reasonable prediction of future conditions. In their "partial recharge" scenario, which corresponds to current plans, ASL (1998) assumed 1,516 acre-feet would be recharged per year from 2000-2010 and 1,762 acre-feet per year from 2010-2020. No effluent recharge would occur after 2020. All recharge controlled by City would be recharged. Currently about 25 percent of effluent entering the wastewater plant originates at Pueblo del Sol. If Pueblo del Sol constructed the infrastructure, it could take delivery of its effluent and use it for irrigating golf courses or other uses. Construction of that infrastructure is uncertain. In the partial recharge scenario, ASL assumed that effluent from Pueblo del Sol would not be available for recharge, and that 50 percent of new development in Sierra Vista would occur on Pueblo del Sol lands. If the infrastructure is not built, and Pueblo del Sol does not take delivery of its effluent, then effluent available for recharge would be greater than that modeled. Thus, the scenario is conservative in regard to effluent provided by Pueblo del Sol, if 50 percent or less of new development in Sierra Vista occurs on Pueblo del Sol lands. Population growth projections for the subwatershed were provided by the Arizona Department of Economic Security and are based on May 1997 projections. These projections are similar to those used by Corell (1996) and the San Pedro Expert Study Team (1999). The model also assumes 1,624 acre-feet of agricultural pumping per year in the subwatershed, which is similar to estimated current agricultural pumping (San Pedro Expert Study Team 1999, Corell *et al.* 1996.) Thus, in regard to population projections and agricultural pumping, the model is realistic. No other recharge or reuse facilities are assumed to exist in the subwatershed through 2040, although Fort Huachuca proposes to reconstruct their effluent ponds to increase recharge, as discussed below. Thus, the model may be conservative in regard to future recharge efforts. The model also assumes evapotranspiration remains at the rate that ADWR (1991) assumed was occurring in 1990 (8,000 acre feet per year). This is similar to the evapotranspiration estimated by the San Pedro Expert Study Team (1999) (7,900 acre feet per year). In summary, ASL's partial recharge modeling scenario could be considered conservative in terms of the amount of effluent that would be recharged and the model uses the best information available to estimate consumptive uses.

Uncertainties about the accuracy of input variables and future conditions suggests the model should be used cautiously. There is much uncertainty in the evapotranspiration estimate, particularly when projected into the future. If groundwater declines in the floodplain aquifer, evapotranspiration would be expected to decline (Stromberg *et al.* 1996, ADWR 1994). BLM and Arizona Game and Fish Department have recently introduced beavers to the RNCA, which may cause additional changes in riparian vegetation communities and evapotranspiration rates. Because evapotranspiration is a relatively large percentage of consumptive water use in the subwatershed [~30 percent (San Pedro Expert Study Team 1999)], relatively small errors in estimating this variable would translate into significant changes in the model output. Qi *et al.* (1998) calculated that evapotranspiration from Lewis Springs to 4 miles north of Fairbank was roughly 7,040 acre-feet per year, suggesting that 8,000 acre-feet may be an underestimate for the subwatershed. However, 86 percent of the 7,040 acre-feet was attributed to mesquite

evapotranspiration, whereas, other research suggests mesquite on the upper San Pedro River may use less groundwater than previously thought (Scott 1998).

Other model inputs are also uncertain. Changes in water use in Mexico (San Pedro Expert Study Team 1999), possible future long term drought or wet periods (Braun *et al.* 1992), changes in the watershed brought about by fire or changing grazing practices, the fate of Fort Huachuca in future base relocation and closure actions, and other elements of uncertainty could all be very important in shaping the water budget in the future. Furthermore, Weisenborn (1995) finds that recharging aquifers by way of recharge basins is not always successful; basins clog with sediments and/or microorganisms requiring regular maintenance. It is unknown how long such facilities can be feasibly operated. ASL (1998) notes that their simulations "are not meant to be a precise prediction of what will happen in the future, but more a qualitative representation of how various pumping/recharge scenarios may affect the groundwater and surface water systems in the future." The model is probably most valuable in estimating relative differences among alternative futures (i.e. is one project alternative better than another at maintaining baseflow), rather than determining absolute future conditions.

There are additional points to consider in evaluating whether the model output corresponds to a reasonable estimate of future conditions. Corell (1996), using the same model as ASL (1998), found that in the later years of the simulations (which were run through 2030), model cells at the base of the Huachuca Mountains were pumped dry. The model shut down pumping in those cells and thus pumping was undersimulated in the later years by 5-8 percent depending on the scenario. In other words, the model reduced pumping in the later years by 5-8 percent over what was inputted into the model. This same problem occurred in the model when used by ASL (Steve Lacey, Fluid Solutions, Phoenix, AZ, pers. comm. 1998). The result is that somewhat less pumpage was simulated than indicated by the input variables and thus the effects on river baseflow may have been underestimated slightly in later years. The underestimate is probably small due to the relatively small reduction in pumpage (5-8 percent), and the distance from the San Pedro River to the cells that went dry (Huachuca Mountain front). Another possible problem is that the model assumes recharge begins in 2000. However, construction is not likely to begin until the latter half of 1999, and the facility will probably not be operational until some time in 2001. Absent recharge, the model shows continued declines over the 1990 baseline; however, these declines would probably be less than 0.1 cfs per year (see attachment 2 of ASL 1998), if declines in baseflow are linear. Thus, a delay in the project of one year should not result in significant or measurable changes in baseflow over current conditions.

Although the above discussion indicates the model should be used cautiously, the presence of a clay deposit in the vicinity of the proposed facility injects additional uncertainty into the results of the ASL modeling effort. The proposed site of the recharge project lies atop the clay deposit, which according to Don Pool could result in the recharged effluent emerging as spring flow at Murray Spring or other nearby springs. The model recognizes the presence of finer

materials in the area, as evidenced by lower transmissivity values in these cells. However, the spring flow would be subject to evaporation and transpiration, which would reduce water available to recharge the aquifer (but evaporation and transpiration would probably amount to no more than a few hundred acre feet per year). The clay deposit also has the potential to alter the effluent flow path, possibly increasing or decreasing the amount of recharge that flows to the river. According to a newspaper article, (former) Sierra Vista Public Works Director George Michael said that the City would consider Pool's findings and may relocate the proposed recharge facility if needed.

Regardless of this uncertainty, the effluent recharge project is expected to be a critical link in maintaining baseflow in the San Pedro River, at least in the near term. Despite the clay deposit, the project should increase the flow of groundwater to the river and reduce the deficit in the water budget. The facility should delay effects of groundwater pumping on water umbel habitat in the San Pedro River and provide additional time to develop and implement other water management strategies. These other strategies would hopefully emerge in the Fort's Water Resources Management Plan, and the Upper San Pedro Partnership's Regional Plan discussed by the Fort in Appendix 1. How much time the project will buy before significant effects manifest is unclear and may depend in part on whether Sierra Vista decides to relocate the effluent recharge facility.

The Fort currently routes 650 million gallons (1,995 acre-feet) of its effluent per year to a wastewater treatment plant. Approximately 40 percent of the treated effluent is used to irrigate landscaping, including a golf course. The remainder is routed to evaporation ponds on the East Range (U.S. Army Reserve 1998). Some of the effluent at the effluent ponds is recharged into the aquifer, but much of the Fort's effluent simply evaporates or is used as irrigation. The Fort proposes to reconstruct the evaporation ponds to increase recharge and modernize the golf course irrigation system. Some effluent currently used to irrigate the golf course would be available for recharge. The Fort's effluent ponds are located west of the clay deposit; thus effluent recharged at this locality would likely flow into the cone of depression (D. Pool, pers. comm. 1999).

Measures other than effluent recharge that lead to increased baseflow or increases in riparian acreage under the various modeling efforts include a pump tax, enforcing a ceiling on domestic water use, requiring minimum irrigation efficiencies, authorizing buy-outs of irrigation water rights (Braun *et al.* 1992), capture and use of surface flows in the watershed outside of the San Pedro River (ASL 1995), and reduced pumping of groundwater (Water and Environmental Systems Technology, Inc. 1994, Corell 1996). The San Pedro Expert Study Team (1999) and Advisory Panel on the Upper San Pedro Initiative (1998) also suggest pumping groundwater directly into the river during extreme drought, housing density restrictions, reduction of irrigated agriculture in Mexico, importation of water from another basin (Douglas basin or from the Central Arizona Project), various water conservation measures, and regulatory

mechanisms, such as establishment of an AMA and/or irrigation non-expansion areas under the Arizona Groundwater Management Act, and pursuing water rights issues under the Gila River adjudication.

The potential effects of groundwater pumping on the San Pedro River ecosystem have been known for some time, and as just discussed, many projects, regulatory mechanisms, and initiatives have been suggested to protect the river. Significant collaborative efforts have recently been initiated to plan for, fund, and implement some of these measures. It is valuable to review these efforts because the committees, agencies, and others behind these efforts are beginning to make significant progress in addressing the region's groundwater deficit.

The Upper San Pedro Partnership has identified a number of strategies to be pursued immediately, including requesting that ADWR move to establish an irrigation non-expansion area in the subwatershed, acquisition of ephemeral arroyos to maximize aquifer recharge, elimination of groundwater pumping within one mile of the river through exchange of State lands and/or acquisition of private lands or water rights near the river, assistance to communities in securing funding for feasibility studies to determine the best use of their effluent, increased recharge of storm water runoff, investigation of moving Bisbee's wells to outside of the San Pedro watershed, and other measures. The Partnership also proposes longer-term water resources planning to develop other strategies.

On June 22, 1999, Interior Secretary Bruce Babbitt and Mexican Ambassador Jesus Reyes-Heroles signed a joint declaration to improve and conserve the natural and cultural resources of the upper San Pedro River basin, including the river and riparian corridor. The declaration creates a partnership to share funds, information, and conservation expertise between land and resource managers in both countries. Planned activities include reprogramming of Land and Water Conservation Funds for purchase from willing sellers of fee titles and conservation easements near Palominas, which should help protect the river from agricultural pumping.

On a State level, the Growing Smarter Initiative was passed by the voters in Arizona which provides a methodology for setting aside state trust lands adjacent to rural cities as open space, creating conservation easements, purchasing development rights easements, etc. In addition, the Arizona Department of Water Resources is active in the rural watershed initiative, chairs the Upper San Pedro Partnership and is engaged in a monitoring program to determine water level changes in the region. The University of Arizona Agriculture Extension Service has been involved in the Water Wise Program encouraging more school education, water audits, etc.

Cochise County is involved in a mountain front recharge instrumentation program with Sierra Vista to quantify the recharge volumes from basins along Buffalo Solder Trail. Since 1992 the

County has actively monitored and participated in the Technical Review Committee to discuss and improve the science and state of hydrology in the region. Cooperative cost sharing is provided for USGS flow gauges at Charleston/Palominas/Babocomari. The County is providing classes at Cochise College on San Pedro water issues, studying urbanization effects on ephemeral stream channel geometry, and participating in an ephemeral stream recharge study with Agricultural Research Service to quantify the recharge volumes from the ephemeral stream on the Walnut Gulch experimental watershed.

Sierra Vista's and Cochise County's Joint Task Force is developing an action plan to protect and enhance the area's environment. The City of Sierra Vista has implemented the Sierra Vista Watershed Protection Program to provide for the sustainable future of the Sierra Vista community while protecting the unique habitat of the San Pedro Riparian National Conservation Area. Protecting this habitat is the primary focus of the Sierra Vista Watershed Protection Program. A San Pedro River informational booklet and video, formation of an environmental affairs commission, establishment of a successful Water Wise Program, and creation of a school programming initiative have also been generated locally. Water consumption is believed to be down 5-10 percent since initiation of the Water Wise Program (Sierra Vista Council Member Casey Jones' letter to the editor, September 5, 1999, Sierra Vista Herald). A surface water plan is in development that will establish a series of storm water detention/retention basins throughout Sierra Vista that would help alleviate flooding and increase recharge opportunities. The City is also participating in a cooperative recharge project with Cochise County and Fort Huachuca. Low-flow fixtures and on-site retention/recharge ordinances have improved the local development code by mandating low water flow fixtures in all new construction and retention of surface flows to pre-construction conditions. In addition, more development code initiatives and changes are currently being considered for adoption and implementation as well. The City recently obtained voter approval to own and operate two local water companies, which gives the City the authority to implement further conservation and recharge measures.

The San Pedro Alliance, a non-governmental entity, was recently created with the objective of providing information and plans for reducing water usage and sustaining the river in the long term. The Nature Conservancy has been active in local forums, and in public education and acquisitions of land and easements. The Udall Center for Studies in Public Policy has also been working in the subwatershed to inspire and enable community members to contribute to water-wise planning and management activities in the upper San Pedro River basin.

Huachuca Water Umbel Localities in the Huachuca Mountains at and near Fort Huachuca

Warren and Reichenbacher (1991) surveyed Fort Huachuca for rare plant species from June to September 1989, and located Huachuca water umbel in upper Garden Canyon and at Sawmill Spring. Microhabitats where the plants were found were low-gradient cienega habitats with

apparently permanent water and stable, non-eroded channels. Sheridan Stone and Jim Hessil of the Fort Huachuca Wildlife Office have since located the water umbel at three additional localities in the upper and middle reaches of Garden Canyon and near McClure Spring in McClure Canyon (Haas and Frye 1997, Jim Hessil, pers. comm. 1998). The species may occur at other wet, boggy areas along Garden Canyon, as well. The Huachuca water umbel also occurs off-post on the west slope of the Huachuca Mountains in Scotia and Sunnyside canyons, and in Bear Canyon and its tributaries. Populations in upper Scotia Canyon are located within one mile of the western boundary (Gate 7) of Fort Huachuca.

As with the San Pedro River, the Huachuca Mountains have a long history of human use. However, it is unclear precisely how those uses affected the habitats of the Huachuca water umbel. Evidence of historic mining activity are commonly encountered throughout the mountain range (Taylor 1991), but mining was probably more important in the Patagonia Mountains to the west and at Tombstone (Hadley and Sheridan 1995, Hereford 1993). Nevertheless, direct impacts of mining, such as tailings piles, roads, areas cleared for settlements, and probably most importantly, fuelwood harvest to support the mines and settlers, likely resulted in localized denuded landscapes and degraded watersheds (Hadley and Sheridan 1995.) A sawmill operated near the mouth of Sawmill Canyon from 1879-1882. Other sawmills operated in Carr, Ramsey, Sunnyside, and Miller canyons off-post (Taylor 1991). By 1902 all usable timber had been harvested from the Huachuca Mountains [General Wildlife Services undated (draft report)]. The Army established a sawmill again at the mouth of Sawmill Canyon in the 1960s, but it operated for only a short period of time and apparently resulted in harvest of very little timber.

Cattle were grazed in the area as early as 1680 (Hadley and Sheridan 1995). Free-ranging cattle were abundant on the Fort in 1886 when the post quartermaster requested fencing of the installation to protect forage for cavalry horses (General Wildlife Services undated). Severe drought combined with overstocking in the 1880s and 1890s led to overgrazing in the region. During the drought, some ranchers drove cattle from the San Rafael Valley into the Huachuca Mountains where forage was cut from oak and ash trees to keep the cattle alive (Hadley and Sheridan 1995.) Livestock were not excluded from Fort Huachuca until about 1950 (General Wildlife Services undated). Currently, the only section of the Fort's boundary that is not fenced is an area just north of Gate No. 7 that is rugged and probably impassable to cattle. Buffalo were maintained on the East Range from approximately 1947-1953. Off-post, the Huachuca Forest Reserve, a precursor to the Coronado National Forest, was established in 1906. At that time policies were initiated to limit grazing to within range capacity and to protect timber resources. These policies were strengthened over time.

Fire regimes for the Garden Canyon watershed and in a study area around Pat Scott Peak in the Huachuca Mountains were reconstructed using dendrochronological methods (Danzer *et al.* 1997). Before 1870 and the establishment of Fort Huachuca (1877), fires were frequent (mean

frequency of 4-8 years), low-intensity (ground fires), and widespread. Since 1870, only 2 widespread fires have occurred (1899 and 1914) in the study area. Danzer *et al.* (1997) attribute this change in fire regime to extensive use of timber, mineral, range, and water resources and associated reductions in fuel loads. Active fire suppression by the Forest Service and others also reduced fire frequency. Exclusion of fire has promoted encroachment of shade-tolerant, less fire resistant tree species such as Douglas-fir, gambel oak, and southwestern white pine, and inhibited growth of ponderosa pine. The 1899 fire was a devastating crown fire that halted all large-scale logging operations at the "Reef" in Carr Canyon and below Ramsey Peak (Danzer *et al.* 1997.) Danzer *et al.* (1997) suggest that the fire regime has been altered from frequent, low intensity fire to infrequent, stand-replacing fires. Recent stand-replacing fires on Carr Peak, Miller Peak, and Pat Scott Peak support this hypothesis.

Most canyons in the Huachuca Mountains today are either too dry to support Huachuca water umbel, or existing permanent streams exhibit high gradients in narrow, shaded canyons that do not provide the boggy, cienega conditions required by this plant. Whether conditions were different in pre-settlement times is unknown and cannot be reconstructed from available historic accounts. However, erosion due to watersheds degraded by overgrazing, timber harvest, and mining, and erosion and downcutting in streams after stand-replacing fires that began in 1899, may have largely eliminated cienega habitats in the canyons of the Huachuca Mountains. Observations of historic versus current distribution of leopard frogs, *Rana pipiens* complex, suggests wetland habitats in the canyons of the Huachuca Mountains may have been altered in historic times. Leopard frogs, which are primarily frogs of low-gradient streams and boggy pools and ponds, were once found in many canyons in the Huachuca Mountains. The frogs are largely absent today, low-gradient streams and sizeable natural pools and ponds are almost nonexistent, and the only places leopard frogs are found with regularity in the Huachuca Mountains are constructed ponds and livestock tanks.

EFFECTS OF THE PROPOSED ACTION

Possible adverse effects to the Huachuca water umbel could result primarily from three components of the proposed action, including 1) groundwater pumping and subsequent decline of surface flows in the San Pedro River; 2) trampling by military personnel during training exercises or by recreationists, and crushing by vehicles; and 3) scouring or sedimentation and resulting loss of plants and habitat due to degraded watershed conditions resulting from high intensity fire or military training activities.

Effects of Groundwater Pumping

Before embarking on a discussion of the effects of groundwater pumping on the Huachuca water umbel, it is prudent to review the requirements of section 7 in regard to effects analyses, because groundwater pumping by the Fort may affect the umbel indirectly and possibly not immediately (possibly not within the life of project), and interrelated, interdependent, or cumulative effects may be more important than activities carried out, funded, or authorized by Fort Huachuca. 50 CFR 402.14(g)(3) requires the Service to "evaluate the effects of the action and cumulative effects on the listed species or critical habitat." "Effects of the action" include "the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interdependent or interrelated with the action, that will be added to the environmental baseline." "Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration" (50 CFR 402.02). The Service's March 1998 Section 7 Handbook provides further guidance on the definition of "interrelated and interdependent actions" by establishing the following rule: "...the analysis of whether other activities are interrelated to, or interdependent with, the proposed action under consultation should be conducted by applying the "but for" test. The biologist should ask whether another activity in question would occur "but for" the proposed action. If the answer is no, that the activity in question would not occur but for the proposed action, then the activity is interrelated and interdependent..." Cumulative effects are "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area" (50 CFR 402.02).

The primary purpose of a biological opinion is to determine, based on analysis of all effects, if a proposed action is likely to jeopardize the continued existence of a listed species or result in adverse modification or destruction of critical habitat. "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. Destruction or adverse modification of critical habitat means a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining habitat to be critical (50 CFR 402.02). If an action is likely to result in jeopardy to a species or in destruction or adverse modification to critical habitat, the Service is required to develop reasonable and prudent alternatives to the action that would avoid jeopardy and adverse modification/destruction of critical habitat. Conclusions in regard to jeopardy and adverse modification or destruction of critical habitat are made based on all of the effects of the action, status of the species, the environmental baseline, and the cumulative effects. Thus, the Service evaluates all information about the status and threats to the species in formulating conclusions about jeopardy and

adverse modification, including activities unrelated to the action under consultation (such as groundwater pumping off-post and not attributable to Fort Huachuca).

50 CFR 402.14(g)(8) requires the Service to use the "best scientific and commercial data available" when formulating a biological opinion, reasonable and prudent alternatives, and any reasonable and prudent measures. In our analyses, the Service summarizes all reports and information available to us on the hydrology of the San Pedro River basin. Although we believe the reports summarily are consistent about the basic hydrology of the San Pedro subwatershed and the long term future of the San Pedro River, some disagreement or inconsistencies can be found within these reports. This is due in part to new information that changes our understanding of hydrological relationships, but in some cases authors differ in their interpretations of data sets. The Service has attempted to base the following analyses and conclusions on the most recent reports, and in order of preference, peer-reviewed published articles, peer-reviewed unpublished reports, non-peer-reviewed unpublished reports, draft reports, and personal communications. Some of the most recent information is in unpublished draft reports that have not been extensively peer-reviewed. Still other information has yet to be written down and is in the form of personal communications. Draft reports and personal communications have been noted as such in the Environmental Baseline. The Service recognizes that the findings in draft reports and personal communications are preliminary and could change upon further review. However, they represent the best information available at this time. If peer review or the publication process alters the findings in these reports or personal communications, or other new information is developed, the Service will revise this effects analysis and our conclusions as needed.

An early draft of this analysis was peer-reviewed by the Water Resources Division of the U.S. Geological Survey, Tucson, Arizona (Appendix 3). The USGS found that the "author(s) did an excellent job of reviewing what has been written, both published and unpublished, about the San Pedro River and paraphrasing the findings." However, USGS goes on to say "Our major comments relate to the conclusions drawn from the information presented." We believe that USGS's primary concern was that the uncertainty over current effects on river flow caused by groundwater pumping in the Fort Huachuca-Sierra Vista area be clearly stated and taken into account in our determination of effects to the water umbel. We have revised the analysis accordingly.

Effects of Unmitigated Groundwater Pumping on River Baseflow

As discussed in the Environmental Baseline, groundwater pumping in the Fort Huachuca-Sierra Vista area has created a large cone or cones of depression in the groundwater aquifer that extend from approximately the Babocomari River southeast for at least 15 miles. Groundwater elevation has declined by as much as 90 feet in this area. If the cone of

depression reaches (or if it has already reached) the San Pedro River, it could reverse the flow of groundwater, cause gaining reaches to become losing reaches, and result in declines or loss of baseflow (ADWR 1994, see Table 3). Before actually reaching the river, baseflow is expected to decline due to reduced hydraulic head between the cone of depression and the river. Such declines have probably been occurring for some time (MacNish 1998, San Pedro Expert Study Team 1999), but the magnitude of decline currently attributable to groundwater pumping and the timing of when the river might be significantly affected by the Fort Huachuca/Sierra Vista cone of depression is unclear. Modeling by Water and Environmental Systems Technology, Inc. (1996) estimated that agricultural users were responsible for 94 percent of the historic loss of river flow through 1988, while municipal and military users were only responsible for six percent. However, the authors did not calculate current contributions to observed baseflow declines. Modeling by ASL (1998) suggests significant effects may occur by 2020 (assuming effluent recharge by Sierra Vista through 2020), while ADWR (1991) believes the river may not be significantly affected for 40 years or more. Although the timing of the effects is uncertain, the modeling efforts and studies reviewed in the Environmental Baseline conclude that flows will continue to diminish or be lost, and in time riparian acreage will be reduced along the upper San Pedro River if groundwater pumping in excess of recharge continues unmitigated.

Effects of Reduced Baseflow on Riverine Habitats and Huachuca Water Umbel

Several changes in riparian and wetland vegetation are expected in response to declining groundwater elevation (Stromberg *et al.* 1996) and are apparently ongoing in certain reaches of the upper San Pedro River (ADWR 1994). Herbaceous aquatic and semi-aquatic plants found in cienegas or marshes, such as the Huachuca water umbel, are most sensitive to groundwater decline (ADWR 1994). Abundance of obligate wetland herbs declines sharply as groundwater depth drops below approximately 10 inches beneath the soil surface (Stromberg *et al.* 1996). Recent changes in riparian and wetland vegetation suggest that groundwater declines are already affecting the habitat of the Huachuca water umbel. Groundwater declines of six feet and three feet have occurred since 1987 on the San Pedro River at Contention (roughly one mile north of the Tombstone gage) and Palominas, respectively. ADWR (1994) notes that "these groundwater declines have been great enough to cause loss of obligate wetland plants and facultative wetland plants." At Contention, seasonal groundwater flux is about six feet and flows are intermittent. In this area groundwater elevation declined too rapidly to allow survivorship of Fremont cottonwood seedlings (ADWR 1994). During surveys for southwestern willow flycatchers in July 1997, SAIC (1998b) noted that in the reach north of the Charleston Narrows to Boquillas, the river was dry and cottonwoods were beginning to lose their leaves. Riparian trees are typically growing vigorously in July.

Due to its ability to thrive on upper floodplain terraces, prevalence of saltcedar, *Tamarix chinensis*, is also predicted to increase under regimes of declining water tables. ADWR (1994)

found that saltcedar is increasing on the San Pedro River below Benson and in the downstream end of the RNCA, where the river loses water to the floodplain aquifer. At Contention, where groundwater is declining, saltcedar is replacing cottonwoods on young floodplains (ADWR 1994). Loss of trees and possibly a change in tree species composition would cause changes in the habitat of herbaceous species, because canopy cover moderates ambient temperatures, alters light quantity and quality, and may affect channel morphology and dynamics (Menges and Waller 1983, Cross 1991, DeLoach 1991). The causes of apparent recent groundwater declines at Contention and Palominas are not known with certainty, but likely include agricultural and perhaps domestic groundwater pumping (Sharma *et al.* 1997, MacNish 1998, ASL 1994, Jackson *et al.* 1987, Water and Environmental Systems Technology, Inc. 1996).

In perennial reaches of the San Pedro River, as water levels decline, suitable water umbel habitat would likely move downslope into what is now the active river channel. Huachuca water umbel would likely be more vulnerable to flood events in these sites. With continuing water declines, perennial reaches would go dry seasonally (probably first in May-June). Huachuca water umbel typically occurs in very shallow water or wetted ground, but can withstand seasonal drought and persist in some intermittent reaches, such as in portions of Bear Canyon and Lone Mountain Canyon on the west slope of the Huachuca Mountains. In intermittent stream segments, increasing dry periods would reduce the ability of the plant to grow, reproduce, and expand populations. Even if the water umbel can survive long periods of drought as seeds or rhizomes (Haas and Frye 1997), at some point increasing aridity would eliminate the plant, including seed stock and rhizomes, from intermittent reaches. Other changes associated with declining water tables, described in the preceding paragraph, could result in changes in shading, temperature, and channel dynamics, with varying effects to water umbel habitat. However, by the time water levels declined to a point that riparian woodlands or shrubs were adversely affected, triggering these additional changes, the water umbel would likely already be extirpated due to dewatering.

Huachuca water umbel occurs in six general areas of the RNCA (near Tombstone Gage downstream of Fairbank, Brunchow Hill upstream of Charleston, in the river at Lewis Springs, north and south of Highway 90, and near Hereford bridge), plus one site approximately 0.5 mile south of the international boundary. Predicting which area might be affected first by declining groundwater levels is problematic and dependent on the estimated rate of decline and current baseflow at specific sites. An examination of current baseflow at each locality suggests that populations near Brunchow Hill, about one mile upstream of Charleston, are perhaps the most resistant to water level changes. Baseflow at the Charleston Gage is more than three times that at Palominas and less variable than flows at the Tombstone Gage (ASL 1995, Vionnet and Maddock 1992). At Brunchow Hill, if water levels continue to decrease (flows have been declining at this site - ASL 1994), water umbel habitat would likely move deeper into the river channel as flows declined. Huachuca water umbel would be extirpated from the area if water levels declined enough to dewater water umbel habitat for extended periods of time. Extirpation could also occur if the taxon was restricted to the bottom of the river channel

and a large flood scoured out the channel. The San Pedro Expert Study Team (1999) noted that although baseflow at Charleston is dependably perennial, at times it is only barely perennial (flows as low as 0.05 cfs have occurred in the last ten years - see Table 2 of the report). Thus, although the population at Brunchow Hill may be more resistant to declining baseflow than other populations, almost any reduction in flow will result in the river becoming intermittent in the Brunchow Hill-Charleston area.

The southernmost Huachuca water umbel locality in the RNCA (from Hereford Bridge north for approximately one mile) is at the upstream end of the perennial reach where baseflows are relatively low. Low flows at Hereford are typically about 40 percent of low flows at Charleston, and periods of no flow have been recorded (Sharma *et al.* 1997). Increasingly intermittent flows and extirpation of the umbel could result if water levels decline at this site. Based on flow data from the BLM gage at the International Boundary, median flows at the site just south of the international boundary are probably about 2 cfs less than at Charleston, and periods of no flow occur.

Flows in the vicinity of the northernmost water umbel population near the Tombstone Gage are highly variable. ASL (1994) notes that it is not uncommon for there to be no measurable flow at the Tombstone Gage. As a result, this population would probably be extirpated if baseflow declined much at all during May-June.

At the Lewis Springs site, where a population occurs in the river, flows are somewhat more than 50 percent of flows at Charleston; periods of no flow have not been recorded (Sharma *et al.* 1997). Relatively low flows at Highway 90 (about one to two miles south of the Lewis Springs site) and Lewis Springs as compared to flows at Charleston, suggest populations at Lewis Springs and Highway 90 are more vulnerable to groundwater decline than the population at Brunchow Hill (near Charleston). However, the lack of no flow periods at Lewis Springs and Highway 90 suggests populations at these sites may be able to sustain greater declines in flow than populations at Tombstone Gage, Hereford, or the site south of the international boundary, where the river currently goes dry periodically.

Predicted rate of groundwater decline is the second factor in assessing risk of population extirpation. USGS (Appendix 3) believes "the San Pedro River above Charleston may not be as vulnerable to pumping from (Fort) Huachuca and Sierra Vista as the Babocomari River and the San Pedro River downstream of Charleston." The presence of a clay deposit reinforces this finding and suggests the reach in the vicinity of the Babocomari confluence would be the first area affected by groundwater pumping at Fort Huachuca and Sierra Vista, followed by the reach north of Charleston, and then the reach from Highway 90 to Charleston (Don Pool, pers. comm. 1999). One water umbel population occurs near the Babocomari confluence (Tombstone gage population). Water umbel has not been found in the perennial reach from

Charleston north to the Babocomari, but the reach from Highway 90 to Charleston supports populations at Brunchow Hill, Lewis Springs, and populations just north and south of Highway 90.

If Sierra Vista's effluent recharge project is successful, flows downstream of the project to at least Fairbank could be bolstered from 2000-2020 (ASL 1998). The fate of populations just south of the international boundary and at Hereford will probably depend, at least in the short term, on agricultural pumping in these areas and are much less likely to be significantly affected by groundwater pumping at Fort Huachuca or Sierra Vista than downstream populations.

Following from the discussions above, the population at Tombstone Gage (downstream of Fairbank) is probably most at risk in the near future. Populations at Brunchow Hill, Lewis Springs, and Highway 90 are expected to be affected next; the former site may be the most robust of the three in terms of maintaining future baseflow. Which of these populations are affected first will depend in part on the location and success of Sierra Vista's effluent recharge project. Flows in the vicinity of the populations near Hereford bridge and near the international boundary will likely depend on the future of irrigated agriculture near the river both north and south of the border, and will likely not be affected by groundwater pumping at Fort Huachuca and Sierra Vista. Although groundwater elevation at Palominas, located between Hereford and the international boundary, has declined by about three feet since 1987 (ADWR 1994), Sharma *et al.* (1987) report that the percentage of flow contributed by groundwater discharge has apparently increased at Hereford.

Effects of the Most Likely Future Scenario

Although continued, unmitigated groundwater pumping in excess of recharge would, in time, result in loss of the Huachuca water umbel from portions of the San Pedro River, pumping is not expected to continue unmitigated. As discussed above, the City of Sierra Vista's effluent recharge program, if successful, will recharge an estimated 2,000 acre feet (or more) of effluent per year. The project should bolster baseflows and create somewhat of a buffer between the river and pumping center at Fort Huachuca-Sierra Vista, although uncertainty exists about how well the project will perform and for how long. The City of Sierra Vista is examining new information about the significance of clay deposits in the area of the proposed effluent recharge facility and may consider changing the location of the project to maximize benefits to the river.

Although the effluent recharge project could buffer the effects of groundwater pumping, the project would only recharge roughly 2,000 acre feet per year under current plans. The deficit in the water budget is currently 7,000 acre feet per year and is expected to grow to 12,570 acre

feet per year in 2030 (San Pedro Expert Study Team 1999). This potential for growth was highlighted recently, when the Sierra Vista City Council approved a plan that could allow 7,000 new homes to be built on 2,000 acres near the San Pedro River, adding 15,000 new water consumers to the subwatershed. In the long-term, if groundwater use continues to exceed recharge, the cone of depression will in time begin to reverse the groundwater gradient to the river, more and more of the effluent will flow to the cone of depression rather than to the river, and baseflow will decline or be lost. Precisely when this would occur is not clear. However, the recharge facility is expected to delay the effects of groundwater pumping on the river, perhaps as long as 20 years (ASL 1998).

The recharge project may mask, temporarily, an ever-increasing threat to water umbel habitats. As a result, the urgency to manage water resources in the basin may wane because of a perception that effects to the river may not manifest for many years to come. However, if the cone of depression is allowed to grow for another 20 years, it may become such an overwhelming problem that dewatering of the river would be inevitable, short of water importation via the Central Arizona Project or the Douglas basin. Given the demand for water in the very rapidly growing Southwest, the likelihood is very low that in 20 years water will be available for importation into the Sierra Vista subwatershed.

Agricultural usage of water in the subwatershed has declined in recent years due to retirement of croplands (San Pedro Expert Study Team 1999, ADWR 1994); however, one farm that was purchased by the Nature Conservancy was recently relocated to another site that is likely to have a greater impact on the hydrology of the river (San Pedro Expert Study Team 1999). Retirement of remaining agricultural lands is possible, either as a means to reduce water use or through conversion of agricultural lands to other uses such as urban development (with which would be associated another suite of potential adverse effects). Reprogramming of Land Water Conservation Funds for acquisitions in the subwatershed as a part of the recent U.S.-Mexico binational initiative could hasten retirement of agricultural lands.

Specific projects to which the Fort is committed (parts V and VI of Appendix A of the MOA - Appendix 1 herein) would reduce water use by a minimum of 600 acre-feet per year within 10 years (Jim Hessil, pers. comm. 1999). These projects include various on-post activities, including additional water conservation, watershed improvement, and water recharge projects. The Service expects that the Fort will develop many additional measures as part of their Army Water Resources Management Plan, but to what degree these measures may reduce net on-post water use is unknown.

The San Pedro Expert Study Team (1999) estimated the water budget for the subwatershed through 2030 under a scenario in which the following projects would be implemented: 1) enhanced mountain front recharge of 1,000 acre-feet per year (corresponds to Fort Huachuca's

proposed watershed improvements as described in SAIC (1998a), 2) continued water conservation programs at Fort Huachuca (increased recharge of 500 acre-feet per year), 3) sewage effluent recharge at Sierra Vista of 2,900 acre-feet per year, 4) water conservation and reduced pumping in domestic wells over a scenario without conservation (gain of 300 acre-feet per year), and retirement of all agriculture in the subwatershed (gain of 1,100 acre-feet per year). Assuming population growth projections of 73,900 and a consumptive use of 9,900 acre-feet per year in 2030, the deficit would be reduced to 6,770 acre-feet per year in 2030. If all irrigated agriculture in Mexico was eliminated, the deficit would be approximately 3,500 acre-feet per year. Thus, the authors found that, even with implementation of a number of major mitigating measures, threats to the baseflow of the river were not eliminated. The San Pedro Expert Study Team found that a means to maintain a viable riparian system was to shift the protected area southward and create a cross-border riparian protection zone, which would probably have to be coupled with water importation from the Douglas basin or the CAP.

The San Pedro Expert Study Team (1999) may not have considered all potentially viable and feasible options for conserving water or increasing recharge. The Upper San Pedro Advisory Panel (1998) recently presented (November 1998) recommendations and findings to the International Commission for Environmental Cooperation. The Panel stated that "while achieving a water balance in the basin represents a significant challenge, we are confident that a focused campaign to save the river will succeed."

If we assume recharge of all possible effluent under control of the City of Sierra Vista [(up to 3,300 acre feet per year by 2030 (ASL 1998)], and implementation of the measures proposed by Fort Huachuca (600 acre feet per year), then 3,900 acre-feet of water per year would be saved or recharged over the current baseline. This assumes that none of the effluent currently used by the City to irrigate pastures is recharged into the aquifer (the total would be less if any recharge is occurring). Assuming withdrawals/outflow exceed recharge/inflow in the Sierra Vista subwatershed by roughly 7,000 acre-feet per year, these mitigating measures, if implemented fully, could cut the current deficit by about 56 percent. However, a balancing of withdrawals/outflow with recharge/inflow would require implementation of additional measures. Without a balancing of the water budget, the cone of depression will continue to grow and continue to pose a long-term threat to flows in the San Pedro River.

Other measures that have a potential to bring the water budget into balance include capture of up to 6,100 acre-feet of ephemeral surface flows per year for use by Sierra Vista (ASL 1995), and retirement of agricultural lands north of the border (1,100 acre-feet per year) (San Pedro Expert Study Team 1999). Implementation of these measures in addition to those described above would create a surplus of roughly 4,100 acre-feet per year over the current situation. However, gains could be negated by increased population growth or new agricultural development and subsequent increased demand for water. Water use at Fort Huachuca is not expected to grow (current water use is 2,355 acre-feet) (SAIC 1998a, J. Hessil, pers. comm.

1999). However, absent additional water conservation, domestic and agricultural water use in the Sierra Vista subwatershed is expected to be approximately 14,700 acre-feet per year by 2030, or approximately 5,300 acre-feet above the year 2000 use (San Pedro Expert Study Team 1999). Thus, if the mitigating measures described above were implemented and water was saved/recharged as estimated, the deficit would be roughly 1,040 acre-feet per year in 2030. As discussed by the San Pedro Expert Study Team (1999), additional water savings of up to 3,500 acre feet per year could be realized by eliminating agricultural pumping in Mexico. Other possible measures which either reduce consumptive use or increase water supply are described by the San Pedro Expert Study Team (1999), Upper San Pedro Advisory Panel (1998), the Upper San Pedro Partnership, and others.

The probability of occurrence of a scenario where the deficit is eliminated by 2030 is dependent upon assumptions that may be invalid. The likelihood that water demand will increase as projected is probably greater than the likelihood that all of the water saving/recharge measures will be implemented. The Fort is able to commit at this time to projects that would save 600 acre-feet per year over the next ten years; although additional measures are expected to be implemented. The feasibility of recharging 6,100 acre-feet of surface flows is unknown (ASL 1995), and there is currently no plan, authority, or funding to phase out agricultural pumping. In fact, without controls on land use, new agricultural development could occur, exacerbating the problem. The City of Sierra Vista's effluent recharge project as currently planned and funded may not operate after 2020, effluent recharged may be considerably less than 3,300 acre feet per year if a local developer, Pueblo del Sol, decides not to participate in the project (ASL 1998), and considerable uncertainties exist about what effects the project will have on local hydrology.

In conclusion, we agree with the San Pedro Expert Study Team (1999) that, in the absence of a concerted effort to reverse current trends, the most likely future scenario is one of continued water use in excess of supply, continued enlargement of the cone of depression under Fort Huachuca and Sierra Vista, and in time, dewatering of portions or all of the San Pedro River in the Sierra Vista subwatershed and associated loss of Huachuca water umbel habitat. The population near the Tombstone gage would likely be affected first by groundwater pumping at Fort Huachuca and Sierra Vista, but populations at Brunchow Hill, Lewis Springs, and near Highway 90 are also threatened by groundwater pumping that is part of the proposed action. Even if enough mitigating measures are implemented so that water supply equals or exceeds water use, the cone of depression is expected to continue its lateral expansion as it flattens out and would likely dewater portions of the San Pedro River [see scenario (1) of Water and Environmental Systems Technology, Inc. 1994 - Table 3], unless effluent recharge is successfully and promptly implemented near the river, or other measures, such as water importation or pumping water into the river are employed to maintain river flow. The success of the effluent recharge project is critical to avoiding these near-term effects to river baseflow and water umbel habitats, but the underlying problem is that as long as water use exceeds

supply the cone of depression will continue to grow and will eventually dewater portions of the river.

Regional water resource planning is needed to address the deficit in the water budget and the associated threat to river baseflow. Fort Huachuca has proposed an Army Water Resources Management Plan and participation in the Upper San Pedro Partnership regional planning effort. It is anticipated that these efforts, combined with the recent bilateral international agreement between the United States and Mexico on protecting the San Pedro River, will provide the framework for long-term planning and actions that will reverse current trends and provide for maintenance of river baseflow and habitats of the Huachuca water umbel on the San Pedro River. Although uncertainties exist, the hydrology of the basin is relatively well understood, and several sets of recommendations on how to reduce consumptive water use and/or increase recharge have been developed over a period of years. If other water users are willing to come to the table with the Fort, the information is available to prepare a regional water management plan to protect the baseflow of the river. The Service expects that this planning effort will be completed and implementation will begin within three years. The Fort has committed to provide considerable leadership, technical support, funding, and other resources to facilitate development and implementation of a plan. Other participants also must provide leadership and resources to develop and implement a plan that is acceptable by the local communities and that will protect river baseflow in the long term. Success of the Sierra Vista effluent recharge project is critical as a means to buy additional time to develop and implement a regional plan before significant effects occur to water umbel habitat.

Effects of Activities at Fort Huachuca Other Than Groundwater Pumping

Activities proposed that have the greatest potential to adversely affect the Huachuca water umbel or its habitat on the Fort include recreational activities, vehicle use, maintenance of roads and firebreaks, water diversions, wildfire ignited by authorized ordnance use or recreation, prescribed fire, and fire suppression. Military training and testing are limited in the canyons of the Huachuca Mountains where this species occurs, and vehicle use is restricted to existing roads and trails. A hiking trail passes by the population at Sawmill Spring. Limited trampling by recreationists likely occurs at this locality, but is not considered a serious threat to this population. The population at Middle Garden Canyon picnic ground is located in the picnic area and likely subject to trampling, but the Fort has recently placed large boulders around the area to prevent vehicles from driving through the habitat. Other populations in Garden and McClure canyons receive less use by recreationists, and trampling and damage by vehicles are less likely to occur in these areas.

A pipeline currently diverts a portion of the flow in Garden Canyon for downstream use. The amount diverted is unknown, but the source is eight springs, with the uppermost spring located

near the pictograph sites. From this point, water is collected and diverted in a pipeline from the various springs along Garden Canyon Creek (Tom Cochran, pers. comm. 1998). Diversion of water can affect extent of downstream water umbel habitat by reducing the size or seasonality of wetted areas. Diversion during 1900-1940 may have been responsible for reduced establishment and vigor of sycamores during that period (General Wildlife Services undated). The aerostat site and Leadership Reaction Course have recently been removed from the Garden Canyon pipeline. The pipeline still delivers water to the latrines at the lower Garden Canyon picnic site and Golf Course and Gravel Pit ponds, but the Fort proposes to halt water use supplied from the pipeline. However, the pipeline infrastructure will remain intact and may be used in the future for mobilizing, emergencies, and fire fighting (Tom Cochran, Fort Huachuca, pers. comm. 1999.) These uses are expected to be infrequent and of short duration, and thus should affect water umbel in Garden Canyon minimally.

Although not directly affected by activities at Fort Huachuca, the Huachuca water umbel population in Scotia Canyon has likely been affected by recreationists that used the road through Gate No. 7 into Scotia Canyon. Sections of this road are highly eroded and braided between Gate No. 7 and the lower Peterson Ranch Pond. The road is a challenge to off-road vehicle enthusiasts, and travel on the roadway often results in erosion, or recreationists seek alternate routes to avoid especially rough sections, which leads to further disturbance and soil erosion. Erosion and sedimentation resulting from use of the road may be affecting Huachuca water umbel populations downstream of the eroded areas. Increased runoff and erosion may result in scouring of the stream channel or burial of plants due to sedimentation. Of particular concern is a head cut just below the lower Peterson Ranch tank. Huachuca water umbel is abundant at the tank and in the reach immediately downstream of the tank. If the head cut moves upstream another 20-40 feet, the tank will be breached resulting in serious erosion and scouring. Use of the road by recreationists could increase the chances that the tank will wash out. Fort Huachuca recently closed Gate No. 7 to vehicular travel and removed the cattle guard. The Fort also plans to post "No Outlet" signs on the Garden Canyon Road near the upper Garden Canyon picnic site and near the mouth of Sawmill Canyon. This closure will probably much reduce traffic through Scotia Canyon because the road is now a dead end. Erosion on other roads or firebreaks in the watershed of the water umbel is unknown, but is also potentially a threat. The road through Garden Canyon is well-maintained and little erosion appears to be associated with its use and maintenance, at least below the mouth of Sawmill Canyon. However, portions of the road may be subject to periodic wash-outs and associated downstream impacts during severe storm events.

Fire and subsequent runoff and erosion of canyon bottoms are the greatest threats to Huachuca water umbel populations on-post in the Huachuca Mountains. Degradation of watershed condition immediately after fires can result in dramatically increased runoff, sedimentation, and debris flow that can scour aquatic habitats in canyon bottoms or bury them in debris (DeBano and Neary 1996). In degraded watersheds, less precipitation is captured and stored, thus perennial aquatic systems downstream may become ephemeral during dry seasons or

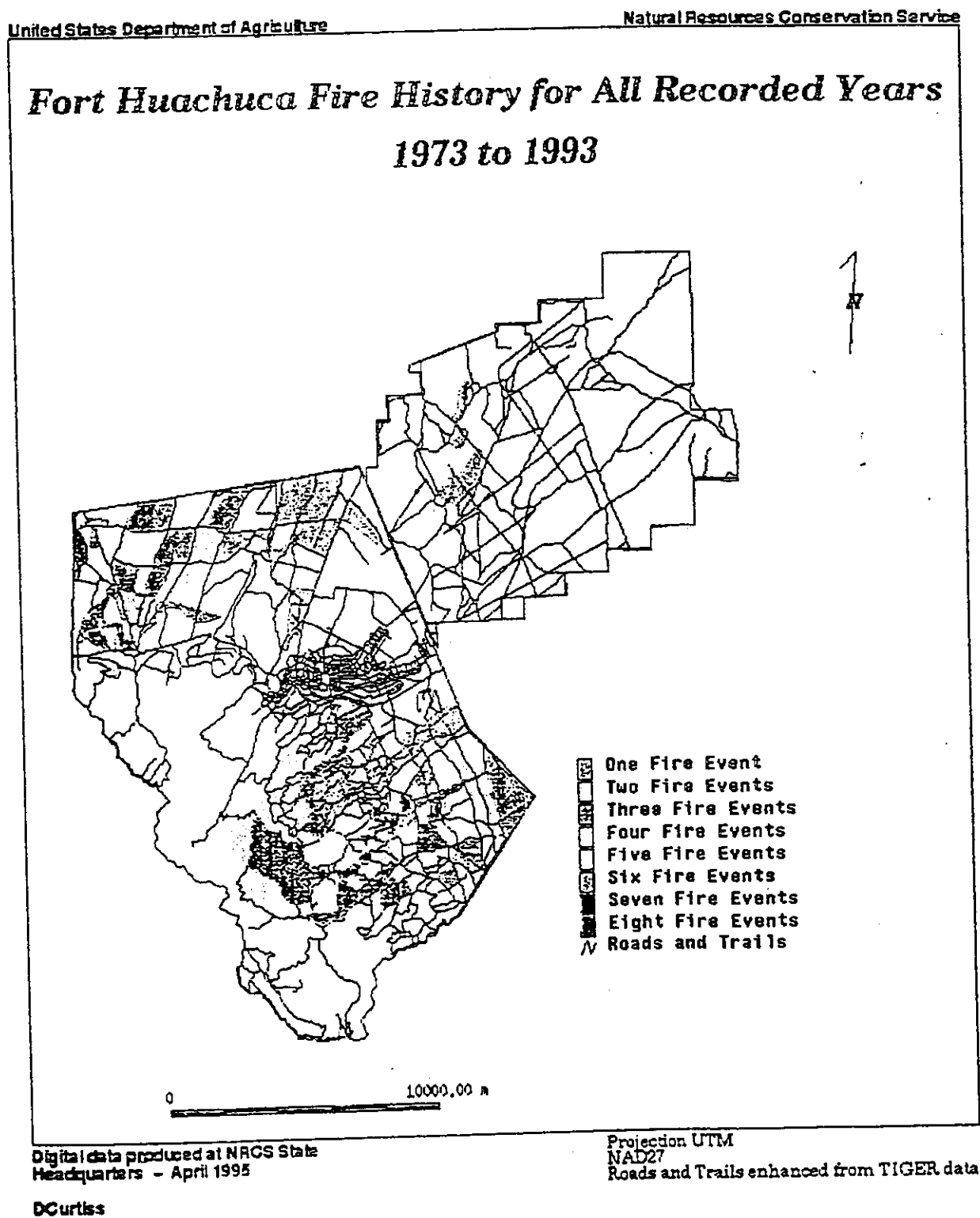
drought (Rinne and Neary 1996). These conditions could result in decline or extirpation of Huachuca water umbel populations in Garden, and McClure canyons, or at Sawmill Spring on the Fort or in adjacent off-post canyons that might be affected by fire on Fort Huachuca (i.e. Scotia and Bear canyon populations). Fires could be intentionally ignited (prescribed fire or arson) or ignition could result from lightning strikes or unintended human ignition such as campfires, cigarettes, or ordnance. Fires associated with campfires or cigarettes are most likely to occur along roadways or at campgrounds and picnic sites. Live fire ranges and firing fans are shown in Figure 4. All Huachuca water umbel populations on Fort Huachuca are close enough to currently-used firing fans that a fire ignited by ordnance could potentially reach the site and adversely affect habitat. Even non-explosive ordnance could result in fire if it landed or skipped on rocks, causing sparks.

Robinett *et al.* (1997) assembled a fire history for the period 1973-1993 (Figure 7). Fires have been few or absent from the higher elevation Huachuca water umbel populations (McClure and Upper Garden canyons, and Sawmill Spring). Several fires burned near the Middle Garden Canyon population and at or near the lower Garden Canyon populations. Although fires at high elevation were infrequent during 1973-1993, recent high intensity crown fires at high elevation to the south of Fort Huachuca (Carr Peak fire in 1977, Pat Scott Peak fire in 1983), combined with high fuel loads in some of these areas (Danzer 1997), suggest that a stand-replacing fire could potentially occur at Fort Huachuca during the life of the project.

General Wildlife Services (undated) suggest that Garden Canyon "is perhaps primed for a catastrophic fire that could lead to major erosion and debris flow on the mid-elevations of the watershed and possible flooding and channel scouring in the lower drainage." They note that there have been no recent fires on the Garden Canyon watershed, fuels are relatively dense, the watershed probably has a deep "regolith" available for debris flow, and the watershed is large enough to collect a sizeable runoff from a major storm event. The Fort has committed to initiating prescribed fires and fuels management in the Huachuca Mountains. A Fire Management Plan has been drafted (Robinett *et al.* 1997) that provides a planning framework for reducing the risk of catastrophic stand-replacing fires. Over time, this effort should significantly reduce the threats to water umbel habitat due to possible erosion, scouring, and sedimentation following a severe wildfire. The risk of a stand-replacing fire that burns over a large area is also reduced due to a network of fire breaks that the Fort maintains along ridgelines and ridgetops.

Wildfires occurred infrequently on the East Range during 1973-1993 (Figure 7). Conceptually, a fire could start on the East Range and spread to the San Pedro River, which is approximately 0.6 mile away from the East Range boundary at its closest point. Fire could destroy riparian vegetation, change the microclimate of water umbel sites, and cause increased runoff, erosion, and sedimentation that could eliminate water umbel populations. However, fires are typically small, the Chihuahuan desert scrub - the dominant vegetation community on the East Range -

Figure 7: Fire history at Fort Huachuca. Taken from Robinett et al. (1997)



provides little fuel to carry fire, and fire breaks and roads prevent fires from spreading very far. Fire breaks surround ZULU, which is a live fire impact zone, and another fire break is located on the east boundary of the East Range. Only one, small fire occurred on the eastern half of the East Range during 1973-1993; and fires ignited on the East Range have never burned into the San Pedro RNCA (J. Hessel, pers. comm. 1998). The Service believes that the threat of fire spreading from the East Range to the San Pedro River is insignificant. Also, conceivably, a live shell could miss ZULU, land in the RNCA, and start a fire. However, this has not happened to date and is considered highly unlikely.

Although active fire suppression is critical to reduce damage from wildfire, suppression activities can adversely affect the water umbel. Decisions made during fire suppression can affect the degree and intensity of fire effects, and the type and location of suppression activities could directly or indirectly affect water umbel habitat. Use of heavy equipment, such as tracked vehicles, to cut fire lines or reduce fuels could destroy habitat, cause erosion, or create new routes of travel that may lead to increased access and recreational impacts. However, the Fort has committed to making protection of water umbel habitat an objective of fire suppression, off-road vehicle activity, including tracked vehicles, would be minimized, a resource advisor would be on-site during all fires to advise the fire boss of species issues, and areas disturbed would be kept to a minimum and located outside of areas important for the water umbel whenever possible.

Watersheds can be degraded by a variety of activities other than fire. The East Range, which encompasses approximately 28,544 acres, lies in the watersheds of the Babocomari and San Pedro rivers. The vegetation and soils of the East Range consist of highly impacted areas intermingled with large tracts of relatively undisturbed habitat. Disturbance has resulted from overgrazing and agricultural development, which predates military use, and military activities such as existing routes, a landing strip, and five off-road maneuvering areas currently not in use (Fort Huachuca 1997a). Watershed condition is degraded in a band, approximately two to three miles in width, that runs across the East Range from the northwest to the southeast.

Brush encroachment and relatively steep slopes results in erosion and downstream sedimentation. Sheet, rill, and gully erosion occur extensively in this area (Fort Huachuca 1997a). Along the eastern boundary of the East Range is an area of soil deposition. Soils eroded off the watershed to the west are being deposited here and later washed away towards the San Pedro River during gully headcutting. Brush is encroaching in this area as well. In other areas of the East Range, the nonnative Lehmann lovegrass, *Eragrostis lehmanniana*, is invading. Watershed condition is improving in these areas due to the ability of Lehmann lovegrass to slow runoff and soil erosion (Fort Huachuca 1997a).

Degraded watersheds can cause increased surface runoff and sediment transport, and decreased infiltration of precipitation (Belsky and Blumenthal 1997, DeBano and Schmidt 1989, Gifford and Hawkins 1979). Potentially, degraded watershed conditions on the East Range could result in higher peak flows, lower low flows, and sedimentation or erosion of the San Pedro and Babocomari rivers. Such conditions could result in increased likelihood that the Huachuca water umbel population near Fairbank, which is downstream of the East Range, could be scoured out during peak flows or buried by sediment. However, studies by the Environment and Natural Resources Division at Fort Huachuca (1997a) indicate that most sediment eroded from the East Range is deposited along the Fort's eastern boundary and does not reach the San Pedro or Babocomari rivers. The lower-elevation portions of San Pedro River watershed are much degraded due to development, a long history of livestock grazing, and conversion of grasslands to shrublands. The effects of watershed degradation on the East Range are probably largely masked by watershed problems elsewhere along the San Pedro River. Limiting vehicles to existing routes and removal of grazing are important steps taken by Fort Huachuca to reduce watershed degradation. Additional measures are planned, such as revegetation, brush control, installation of structures to slow erosion and trap sediment, placement of waterbars along roads, and closure of unneeded routes (Fort Huachuca 1997a). Implementation is subject to available funding.

Indirect, Interrelated, and Interdependent Effects

Groundwater Pumping Off-Post

In regard to groundwater withdrawals, indirect effects and the effects of activities interrelated and interdependent to the Fort's presence, are probably more important than the actual groundwater pumping that occurs on the Fort. Groundwater pumped by the Fort totals approximately 2,355 acre-feet per year (SAIC 1998a). Estimated net water use is approximately 1,900 acre feet due to recharge at the effluent evaporation ponds and elsewhere. With implementation of recharge/watershed improvements currently committed to by the Fort (estimated savings of 600 acre-feet per year), net water use in 2009 would be roughly 1,300 acre feet per year. With implementation of other measures to be developed in the Army Water Resources Management Plan, additional, but undetermined savings should occur.

There is also groundwater pumping off-post that would not occur "but for" the presence of the Fort. The effects of such pumping are interrelated and interdependent to the Fort's activities. Estimating the effects of these interrelated and interdependent activities is complicated because the number of people living in the Sierra Vista subwatershed that would not be there "but for" Fort Huachuca can not be precisely quantified. However, at a minimum, the current effects of the proposed action (direct, indirect, interrelated, and interdependent effects) can be bracketed with low and high end estimates. At the low end would be the amount of water pumped from the Fort's wells: 2,355 acre feet per year. This assumes none of the pumping outside of the Fort's boundaries occurs but for the Fort's presence (no indirect, interrelated/interdependent

effects). At the high end, we could assume that all of the water pumped at Fort Huachuca, Sierra Vista, and other domestic (non-agricultural) wells in the subwatershed is attributable to the Fort (8,300 acre feet - from the year 2000 estimate by San Pedro Expert Study Team 1999). This represents 28-100 percent of the domestic groundwater pumping in the subwatershed, and 25-88 percent of the total groundwater pumping in the subwatershed. An unknown amount of this pumped water is recharged in various ways (at the Fort's effluent evaporation ponds, in septic tanks, etc.), thus the net water removed from the aquifer is something less. However, if we assume the cause of the deficit in the water budget is groundwater pumping, then the Fort's contribution to that deficit is 25-88 percent (percentage of total groundwater pumping in the subwatershed attributable to the Fort).

Both the low and high ends of this range are unrealistic, because the Fort clearly can not be held responsible for all domestic groundwater pumping in the subwatershed, but yet some indirect, interrelated, or interdependent groundwater pumping off-post certainly occurs. Nevertheless, refining the amount of groundwater pumping attributable to the Fort any further is problematic. A recent economic report (Fort Huachuca 1998) and demographic study (SAIC 1999) provide population data allowing some narrowing of our estimate of indirect, interrelated, and interdependent effects. Calculating these effects can be performed several different ways.

Fort Huachuca has calculated the acre-feet of water attributable to the Fort's presence by starting with the amount of water pumped on-post (2,355 acre feet/year) and then adding in water pumped off-post to support military and civilian employees and their dependents, contractors and their dependents, and military retirees and survivors (Appendix 4). This analysis depends heavily on the information provided in Fort Huachuca (1998) and SAIC (1999). The analysis corrects for double or triple counting of individuals in different categories (i.e. some retirees are also contractors, some contractors are also dependents of military personnel, etc.). From the Table in Appendix 4, off-post water use attributable to Fort Huachuca is 2,560 acre-feet/year. This, added to on-post use, totals 4,915 acre-feet/year.

Appendix 4 is a good analysis, based on best available information, of water use attributable to the Fort's employees (military, civilian, and contractors) and their dependents, military retirees, and military survivors. However, this may not reflect the complete effect that Fort Huachuca has on the water use in the subwatershed. The local economy has expanded due to the economic effects of the Fort. For example, some businesses and the employees they support probably would not be in the Sierra Vista area but for the Fort's presence, even though those businesses do not deal directly with Fort Huachuca. Also, some people probably move to the Sierra Vista area due in part to amenities, such as shopping and entertainment, that might not exist in a smaller community without Fort Huachuca. Accurately estimating the number people in the subwatershed due to this aspect of the Fort's influence on the local economy is difficult, at best. However, the Fort has estimated that this factor adds an

additional 1,228 people that would not live in the subwatershed but for the presence of Fort Huachuca (Appendix 4).

Water usage per capita is the next figure that must be estimated. ASL (1998) estimated that each person in the subwatershed uses approximately 164 gallons of water per day. In a letter to the editor in the September 5, 1999, edition of the Sierra Vista Herald, Sierra Vista City Council Member Casey Jones presented data indicating per capita use for the three largest water companies that operate in Sierra Vista is 120-126 gallons per day. Fort Huachuca uses the figure of 150 gallons per day for per capita use on post (Appendix 4). If we use the middle figure (150), and assume an additional 1,228 people live in the subwatershed as a result of Fort Huachuca, then roughly $1,228 \times 150 \times 365 = 67,233,000$ gallons, or 206 acre-feet per year are attributable to these individuals. Added to the 4,915 from above, a total of 5,121 acre-feet per year of groundwater pumping in the Sierra Vista subwatershed would be attributable to the Fort's presence.

Note that the 5,121 figure is composed of 1) groundwater pumping on-post (2,355 acre-feet), 2) pumping off-post due to military and civilian employees and contractors, and their dependents, and retirees and survivors (2,560 acre-feet), and 3) pumping due to other businesses and residences that otherwise would not be in the subwatershed but for Fort Huachuca (206 acre-feet). The level of uncertainty in the components of the total increases from 1) to 3). The estimate of groundwater pumping on-post is firm, groundwater pumping in part 2) requires acceptance of certain assumptions, and thus is less certain, while the estimate for part 3) is a best guess.

The Service presents the following alternative analysis for estimating direct, indirect, interrelated and interdependent effects. Fort Huachuca (1998) applied an economic multiplier of 1.684 to the Fort's 10,362 person work force and estimated that Fort Huachuca supports 17,540 job equivalents in Cochise County. A small percentage (less than five percent) of Fort Huachuca employees live outside the watershed (SAIC 1999). This percentage is probably higher relative to the number of jobs in the County supported by Fort Huachuca. If we assume 10 percent of the 17,540 are individuals that live outside of the subwatershed, then the Fort would support 15,786 job equivalents in the subwatershed. SAIC (1999) found that 4.9 percent of Fort Huachuca employees held second jobs; thus this figure should be reduced to 15,013. An unknown number of dependents are associated with these individuals. However, dependents associated with military and off-post Fort employees averaged 2.1 and 1.8, respectively (SAIC 1999). Roughly a third of the military dependents are also Fort employees (SAIC 1999), so to avoid double counting them, the 2.1 and 1.8 figures should be reduced to 1.4 and 1.2, respectively. If we average these (1.3) and assume this corresponds to the number of dependents associated with those employed in the subwatershed as a result of Fort Huachuca's presence, then a total $15,013 + (1.3 \times 15,013) = 34,530$ people live in the subwatershed because of the Fort's presence. This could be conservative, because it does not

count military and Department of Defense retirees; however, many retirees are employed at Fort Huachuca (SAIC 1999), may be dependents of those employed there, or live in the subwatershed for reasons other than the Fort's presence. If we use 150 gallons per day for per capita use, and assume 34,530 people live in the subwatershed as a result of Fort Huachuca, then roughly $34,530 \times 150 \times 365 = 1,890,517,500$ gallons, or 5,802 acre-feet per year are attributable to the Fort's presence. This estimate requires acceptance of numerous assumptions and thus probably includes as much uncertainty as parts 2) or 3) of the Fort's estimate of 5,121 acre-feet. Despite the very different methods for calculating effects, the end results (5,802 versus 5,121) are quite similar.

In summary, effects (direct, indirect, and interrelated/interdependent effects) attributable to Fort Huachuca include pumping of an estimated minimum of 2,355 to a maximum of 8,300 acre-feet per year from the Sierra Vista subwatershed. Rough estimates within that range are 5,121-5,802 acre-feet per year. This represents (roughly) 54-62 percent of all groundwater pumping in the subwatershed ($5,121/9,400$ and $5,802/9,400$: 9,400 is the year 2000 estimate of total pumping from the San Pedro Expert Study Team 1999). This range, 54-62 percent, would also roughly represent the Fort's contribution to the deficit in the subwatershed's water budget. We stress that these estimates are considered best guesses; other reasonable methods of calculation could generate different results. These estimates should be revised as new information is developed.

Other Off-Post Activities

The presence of a population of Fort Huachuca employees, contractors, dependents, and others in the Sierra Vista subwatershed has other effects on the water umbel and its habitat. Agricultural and urban development may result in watershed degradation and subsequent adverse effects to biotic integrity and habitat quality in adjacent riparian systems (Wang *et al.* 1997). In Wisconsin, urbanization rates of between 10 and 20 percent in watersheds consistently resulted in low indices of biotic integrity (Wang *et al.* 1997). Urbanization results in increased runoff, and resulting changes in flow regimes, water temperature, and channel morphology (Wang *et al.* 1997, Schueler 1994). Runoff from urban areas also reduces water quality by carrying toxicants and high nutrient loads (Wang *et al.* 1997).

The increased human population in the subwatershed as a result of Fort Huachuca probably also results in increased recreational use of Huachuca water umbel sites, both on- and off-Post. Increased recreational use results in greater chance of fire, trampling, and off-road vehicle damage, all of which can adversely affect water umbel populations.

Other Activities at Fort Huachuca

Fort Huachuca provides support services for other DOD units. For instance, the civilian personnel operations center provides support services for 14 military installations in six western states. Computer and other support services are also stationed at Fort Huachuca that serve other military installations. However, the Service does not consider the activities of these off-post units interrelated or interdependent to the Fort's proposed action. This is because these service's would still occur at other military installations if they were eliminated at Fort Huachuca. These are basic support services that would be stationed elsewhere, if not at Fort Huachuca.

Many DOD units train at Fort Huachuca. When training at Fort Huachuca, the effects of that training are part of the effects of the proposed action, because such training must be approved by Fort Huachuca. However, the effects of the activities of these units when not at Fort Huachuca are not effects of the proposed action, because they are not interrelated or interdependent to the proposed action. In discussions with Fort personnel, the Service has determined that if these DOD units did not train at the Fort, they would train at another military installation. No unit could not exist or train but for the existence of Fort Huachuca, thus the activities of these units outside of Fort Huachuca are not interrelated to or interdependent on the proposed action.

Cumulative Effects

Groundwater Pumping

Cumulative effects of groundwater pumping on water umbel habitat in the San Pedro River are perhaps even more important than the effects of interrelated and interdependent activities. Cumulative effects include the effects of future State, tribal, or local private actions that are reasonably certain to occur in the project area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. Effects of past Federal and private actions are considered in the Environmental Baseline.

Although employment and effective population at Fort Huachuca are expected to remain fairly constant (SAIC 1998a), the population of the Sierra Vista subwatershed is expected to increase from the 1990 estimate of 51,400 to 73,900 in 2030, with a resulting increase in consumptive water use of approximately 5,300 acre-feet per year over current use (San Pedro Expert Study Team 1999). Because the Fort is not expected to grow, this increase cannot be attributed to the Fort; although it is not possible to predict how growth in the subwatershed might be affected if the Fort was not present. Nevertheless, it is clear that growth in the area has

achieved momentum that is separate from any influence Fort Huachuca might have. The projected growth in water consumption in the subwatershed and the resulting continued deficit between recharge and use pose the greatest threat to the water umbel and its habitat on the San Pedro River.

Of great concern is the potential for additional agricultural development and associated pumping of groundwater in the floodplain of the San Pedro River in either the U.S. or Mexico portions of the river. Extensive acreage exists in Mexico and on private and State lands within the U.S. portion of the watershed that could potentially be developed for agriculture (San Pedro Expert Study Team 1999). This may become less of a threat if initiatives to designate irrigable lands as irrigation non-expansion areas or if purchase of lands or easements from willing sellers are implemented. As discussed in the 'Environmental Baseline' a number of initiatives and planning processes are underway at local, State, Federal, and international levels that are expected to reduce cumulative effects due to groundwater pumping in the upper San Pedro River basin.

Other Activities

Most other activities that may adversely affect the Huachuca water umbel in the project area would involve a Federal action, and thus are not considered cumulative effects. Exceptions may include activities on private lands in Scotia, and Bear canyons on the west slope of the Huachuca Mountains, and at other sites in the San Rafael Valley. The most likely impacts in these areas would be livestock grazing. The species is apparently able to coexist with well-managed livestock grazing; however, historic and long-term effects of grazing on riparian systems supporting the water umbel have been detrimental. Effects of livestock grazing on the water umbel on lands managed by the Coronado National Forest were recently addressed in a formal section 7 consultation. Private lands in Scotia Canyon may be acquired by the Coronado National Forest through a land exchange.

Effects to Critical Habitat

Critical habitat for the Huachuca water umbel was designated July 12, 1999, in the project area on 3.8 miles of upper Garden Canyon on Fort Huachuca, and 33.7 miles of the upper San Pedro River from approximately 600 feet south of Hereford Bridge to just north of Fairbank. Critical habitat was also designated in nearby Scotia Canyon, just west of Gate No. 7 of Fort Huachuca, and in other canyons on the west slope of the Huachuca Mountains. Effects analyses must determine if the proposed action would destroy or adversely modify critical habitat. "Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying

any of those physical or biological features that were the basis for determining the habitat to be critical (50 CFR 402.02). The primary constituent elements identified in the final rule as necessary for the survival and recovery of the Huachuca water umbel include, but are not limited to, the habitat components which provide the following:

- (1) Sufficient perennial base flows to provide a permanently or nearly permanently wetted substrate for growth and reproduction of Huachuca water umbel;
- (2) A stream channel that is relatively stable, but subject to periodic flooding that provides for rejuvenation of the riparian plant community and produces open microsites for water umbel expansion;
- (3) A riparian plant community that is relatively stable over time and in which nonnative species do not exist or are at a density that has little or no adverse effect on resources available for water umbel growth and reproduction; and
- (4) In streams and rivers, refugial sites in each watershed and in each reach, including but not limited to springs or backwaters of mainstem rivers, that allow each population to survive catastrophic floods and recolonize larger areas.

As discussed in the "Effects of Groundwater Pumping" and "Interrelated and Interdependent Effects", without a concerted effort to balance the water budget or otherwise mitigate the impacts of groundwater pumping, dewatering and loss of riparian vegetation is likely as a result of the proposed action on portions of the 33.7 miles of critical habitat on the San Pedro River. Critical habitat north of Charleston, particularly near the Babocomari confluence, (15.3 miles) is most at risk, followed by the reach from Highway 90 to Charleston (5.5 miles). The City of Sierra Vista's effluent recharge project is expected to delay these effects if the project is successful (ASL 1998), but in the long term baseflows and the constituent elements of water umbel critical habitat are threatened by groundwater overdraft. Evidence suggests that dewatering is already occurring, although the cause is unclear and may or may not currently be attributable to effects of the action (San Pedro Expert Study Team 1999, Koehler and Ball 1998, Pool *et al.* 1998, MacNish 1998, SAIC 1998b, Fenske 1998, Sharma *et al.* 1997, Water and Environmental Systems Technology, Inc. 1996, ADWR 1994, ASL 1994). Cumulative effects are as described above for the species. These effects exacerbate the effects of the action. Of particular concern is the potential for agricultural development near the river, which could result in dewatering the only portion of critical habitat on the San Pedro River that may not be affected by the project (Hereford to Highway 90).

Because the upper San Pedro River is the only large, contiguous habitat of the water umbel, it is the most important of the critical habitat areas to the survival and recovery of the species. Loss of this habitat would appreciably diminish the value of critical habitat for both the survival and recovery of the Huachuca water umbel. In the final critical habitat rule, the Service found that activities such as excess groundwater pumping that appreciably decreases base flow and appreciably reduces the wetted surface area of perennial rivers or springs may destroy or adversely modify critical habitat. Unless a concerted effort is made to manage water resources in the subwatershed, groundwater use will continue to exceed supply, resulting over time in a significant loss of Huachuca water umbel critical habitat on the upper San Pedro River. The Fort's proposed Army Water Resources Plan and the Upper San Pedro Partnership's regional planning process provide a framework for such an effort. Fort Huachuca has committed to contributing considerable leadership, technical support, funding, and other resources to hasten the success of these efforts. Successful implementation of the Sierra Vista effluent recharge project should provide the time necessary to develop and implement these plans before significant effects occur to river baseflow.

Activities at Fort Huachuca other than groundwater pumping also have a potential to adversely affect critical habitat (see "Effects of Other Activities at Fort Huachuca"). These activities include recreational activities, vehicle use and maintenance of roads and firebreaks, water diversions, wildfire ignited by authorized ordnance use or recreation, prescribed fire, and fire suppression. The most important of these are wildfire and prescribed fire, and fire suppression activities. The effects of these actions are described in the "Effects of Other Activities at Fort Huachuca" above. Wildfire ignited by recreationists or ordnance, prescribed fire, and fire suppression activities could result in direct effects to water umbel critical habitat in Garden Canyon, or perhaps in nearby Scotia Canyon. Indirect effects could also occur from these activities, particularly as a result of watershed degradation and subsequent erosion, sedimentation, and changes in stream hydrology. The Fort has proposed a number of measures to reduce the chance of catastrophic fire in the Huachuca Mountains and to minimize adverse effects to critical habitat due to fire suppression activities.

Effectiveness of Proposed Mitigation

The Fort proposed several significant mitigating measures that would reduce adverse effects to the Huachuca water umbel and its proposed critical habitat. The Fort has established an administrative process for limiting adverse effects to listed species that includes a point of contact, training and education of personnel in endangered species issues and requirements, strict training range management procedures, and development of an Integrated Natural Resources Management Plan and individual management plans for each listed species. The Fort limits vehicular use to existing routes, has recently closed Gate No. 7, and is taking the additional step of erecting barriers (such as placing boulders) around sites with Huachuca water umbel to prevent damage by off-road vehicles.

Mutual aid agreements with the Coronado National Forest and local governments, requirements to have fire suppression capability on site during training exercises, fire breaks, the ability to implement seasonal closures, and other authorities available to the Range Control Officer provide the capability to suppress or prevent wildfires. Measures have been adopted to reduce habitat damage and loss of plants resulting from suppression activities. Fort Huachuca plans to implement prescribed fire and mechanical reduction of fuels to reduce the chance of stand-replacing fire.

Mitigation measures are adequate to remove the most serious threats to Huachuca water umbel populations on the Fort. Measures recommended by Fort Huachuca (1997a) are also adequate to improve degraded watershed conditions on the East Range and thus reduce watershed-related threats to the water umbel population and critical habitat near the Tombstone gage on the San Pedro River. These measures would have to be implemented promptly and successfully to avoid adverse effects to critical habitat.

The Fort should be commended for implementation of many water conservation practices that have reduced water use in recent years (SAIC 1998a). Such practices could serve as models for other water users in the subwatershed. If currently proposed water management projects are implemented (Appendix A of the MOA - Appendix 1 herein), water savings/recharge of up to 600 acre-feet per year could result, reducing net direct water use by the Fort to approximately 1,300 acre-feet per year. As discussed above, despite these efforts by the Fort, implementation of these mitigation measures, as well as measures proposed by the City of Sierra Vista, would, even under optimistic conditions, still result in water use from the aquifer in excess of water supply and result in continuing growth in the already very large cone of depression under Fort Huachuca and Sierra Vista. The City's effluent recharge project, if it is constructed and operated as expected, may insulate a significant reach of the river from the effects of groundwater pumping for perhaps as long as 20 years. However, ultimately, as long as the water budget is in deficit, water umbel populations and critical habitat are threatened.

To address this larger problem, the Fort has committed to developing an Army Water Resources Management Plan and to participate in the development of a Regional Water Resources Plan with other water users in the subwatershed. The goal of the Army Water Resources Management Plan is to maintain the Army's mission at Fort Huachuca while protecting and maintaining populations of listed species and their habitats. The Army's goal for the Regional Plan is to maintain baseflows in the upper San Pedro River sufficient to sustain species and habitats protected by the Endangered Species Act. These plans would be developed over the next three years. A variety of teams and partnerships, such as the Upper San Pedro Partnership, the San Pedro Expert Study Team, Advisory Panel on the Upper San Pedro Initiative, recommendations of the Water Issues Group, as well as designation of the San Pedro River RNCA and negotiations on the ongoing Gila River adjudication all have provided direction, ideas, and incentive to protect the riparian resources of the upper San Pedro River.

Taken together, they provide a framework for Fort Huachuca to work with other agencies, the City of Sierra Vista, and others to protect water umbel populations and critical habitat. The Service believes the Fort will be successful in developing with others in the basin water management plans within three years that, when implemented, will protect water umbel populations and constituent elements of critical habitat. If the effluent recharge project works as anticipated herein, effects to the river from groundwater pumping should be delayed long enough to devise and implement these plans before the water umbel or its critical habitat are significantly affected.

CONCLUSION

After reviewing the current status of the Huachuca water umbel, the environmental baseline for the action area, the effects of the Fort's activities, and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Huachuca water umbel and is not likely to result in adverse modification and destruction of critical habitat. We present these conclusions for the following reasons:

1. The Fort has committed to develop an Army Water Resources Management Plan and to work with others to develop a Regional Water Resources Plan. The goal of the Army Water Resources Management Plan is to maintain the Army's mission at Fort Huachuca while protecting and maintaining populations of listed species and their habitats. The Army's goal for the Regional Plan is to maintain baseflows in the upper San Pedro River sufficient to sustain species and habitats protected by the Endangered Species Act.
2. The Fort has proposed mitigating measures to significantly reduce or eliminate effects of the proposed action to populations of water umbel and its critical habitat on post.
3. The Bureau of Reclamation and City of Sierra Vista are developing an effluent recharge project that is expected to delay effects to river baseflow and water umbel habitats on the San Pedro River resulting from groundwater pumping at or attributable to Fort Huachuca. Although this project does not alleviate the long-term threat to water umbel habitats on the San Pedro River, it is expected to provide time to develop and implement plans to address those long-term threats before further impacts to the umbel or its critical habitat occur.

The Service's findings that the proposed action is not likely to jeopardize the continued existence of the water umbel or result in adverse modification or destruction of critical habitat are based entirely on the successful and prompt implementation of Sierra Vista's effluent recharge project to avoid near-term impacts, the Fort's commitment to develop and implement water resources planning to protect in the long-term the water umbel and its habitat on the San

Pedro River, and the Fort's proposed mitigation measures to protect the species and its habitat on-post. If these plans and mitigation measures are not implemented on schedule or do not reduce or eliminate adverse effects as predicted herein, then reinitiation of consultation is warranted and the Service would need to reevaluate its conclusions [50 CFR 402.16(b and c)].

The Service bases its biological opinion on the effects of the action (direct and indirect effects, and effects of interrelated and interdependent activities), the cumulative effects, the environmental baseline, and the status of the species. If the Service and the Army reinitiate this formal consultation; then, as was done herein, effects of groundwater pumping by all pumpers in the project area on the water umbel and its critical habitat (including all cumulative effects) must be evaluated in determining whether the Army's actions jeopardize the species or results in adverse modification or destruction of critical habitat. An alternative to this scenario is for the Army to zero out its effects (direct, indirect, interrelated, and interdependent effects) to the water umbel and its critical habitat, or reduce them to such a level that they are insignificant or discountable (insignificant effects relate to the size of the impact and should never reach the scale where take occurs; discountable effects are those extremely unlikely to occur). In this case the Army could request a concurrence from the Service that the proposed action may affect, but is unlikely to adversely affect, the water umbel and its critical habitat [50 CFR 402.14(b)]. In evaluating whether or not to concur with such a request, the Service does not consider cumulative effects.

Note that in regard to "take" of listed species in sections 7(b)(4) and 7(o)(2) of the Act, these sections generally do not apply to listed plant species, thus no incidental take statement is included here for the Huachuca water umbel. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed endangered plants and malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulation or in the course of any violation of a State criminal trespass law.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act direct Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information on listed species. The recommendation provided here does not necessarily represent complete fulfillment of the agency's section 2(c) or 7(a)(1) responsibilities for the Huachuca water umbel. In furtherance of the purposes of the Act, we recommend implementing the following action:

1. The Fort should provide assistance to the Service in developing a recovery plan for the Huachuca water umbel. In addition, the Fort should develop and implement with the BLM and the Coronado National Forest a regional conservation plan for managing the Huachuca water umbel in the San Pedro River/Huachuca Mountains/San Rafael Valley region.

2. In the proposed mitigation measures, the Fort has proposed to assist the BLM and other land owners with habitat management or restoration of umbel habitat that has been degraded or lost. Off-post projects that the Fort should consider funding include, but are not limited to, cienega restoration or protection in Scotia Canyon or elsewhere in the Huachuca Mountains, if approved by and coordinated with the landowner(s), and restoration or protection of cienega conditions on the San Pedro River RNCA, if approved by and coordinated with the BLM.

3. The Army's Water Resources Management Plan should have as an objective balancing groundwater withdrawals with recharge on Fort Huachuca by 2009.

4. The Fort should recognize and support the need to balance water use with water supply in the Sierra Vista subwatershed and encourage other water users in the subwatershed to endorse, through the Regional Water Resources Planning effort, this goal.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species, the Service requests notification of implementation of any conservation actions.

(Note: research or other activities that result in collection of Huachuca water umbel or parts thereof require appropriate permits from the Service and Arizona Department of Agriculture.)

Southwestern Willow Flycatcher

STATUS OF THE SPECIES

The southwestern willow flycatcher is a small passerine bird (Order Passeriformes; Family Tyrannidae) measuring approximately 5.75 inches in length from the tip of the bill to the tip of the tail and weighing only 0.4 ounces. It has a grayish-green back and wings, whitish throat, light gray-olive breast, and pale yellowish belly. Two white wingbars are visible (juveniles have buffy wingbars). The eye ring is faint or absent. The upper mandible is dark, the lower is light yellow grading to black at the tip. The subspecies was listed as endangered under the

Act on February 27, 1995 (Service 1995a). Critical habitat was designated on July 22, 1997, and includes 18 critical habitat units totaling 599 river miles in Arizona, California, and New Mexico. In Arizona, critical habitat was designated along portions of the San Pedro River, Verde River, Wet Beaver Creek, West Clear Creek, Colorado River in the Grand Canyon, and Little Colorado River (Service 1997b).

One of four currently-recognized willow flycatcher subspecies (Phillips 1948, Unitt 1987, Browning 1993), the southwestern willow flycatcher is a neotropical migratory species that breeds in the southwestern U.S. from approximately April 1 to September 1 and migrates to Mexico, Central America, and possibly northern South America during the non-breeding season (Phillips 1948, Stiles and Skutch 1989, Peterson 1990, Ridgely and Tudor 1994, Howell and Webb 1995). The historical range of the southwestern willow flycatcher included southern California, Arizona, New Mexico, western Texas, southwestern Colorado, southern Utah, extreme southern Nevada, and extreme northwestern Mexico (Sonora and Baja) (Unitt 1987). The flycatcher is a riparian obligate, nesting along rivers, streams, and other wetlands where dense growths of willow, *Salix* sp., seepwillow, *Baccharis* sp., buttonbush, *Cephalanthus* sp., boxelder, *Acer negundo*, saltcedar, *Tamarix chinensis*, or other plants are present, often with a scattered overstory of cottonwood and/or willow. Of 203 monitored low-elevation nests in Arizona in 1998, 194 were constructed in saltcedar, seven in willow, one in buttonbush, and one in seep willow. All nests at high elevation in Arizona were built in Geyer willow, *Salix geyeriana* (Paradzick *et al.* 1999). Flying insects, particularly Hymenoptera (ants, bees, and wasps), Diptera (flies), and Hemiptera (true bugs), are the most important prey of the southwestern willow flycatchers; however, they will also glean larvae of non-flying insects, such as Lepidoptera (butterflies and moths), from vegetation (Drost *et al.* 1998).

Unitt (1987) reviewed historical and contemporary records of *E.t. extimus* throughout its range, determining that it had "declined precipitously..." and that although the data reveal no trend in the past few years, the population is clearly much smaller now than 50 years ago, and no change in factors responsible for the decline seem likely. Roughly 587 flycatcher territories occurred in 1997. Breeding by roughly 350-550 pairs occurs at approximately 88 sites (Service files). Most breeding sites include five or fewer breeding territories, and many are likely remnants of formerly much larger populations (Sferra *et al.* 1997, Cooper 1997, Sogge *et al.* 1997). Declining numbers have been attributed to loss, modification, and fragmentation of riparian breeding habitat, loss of wintering habitat, and nest predation/brood parasitism by the brown-headed cowbird, *Molothrus ater* (McCarthy *et al.* 1998, Sogge *et al.* 1997). Habitat loss and degradation is caused by a variety of factors, including urban, recreational, and agricultural development, water diversion and groundwater pumping, channelization, and livestock grazing. Fire is an increasing threat to willow flycatcher habitat (Paxton *et al.* 1996). Fire frequency in riparian vegetation increases with dominance by saltcedar (DeLoach 1991), and water diversions or groundwater pumping that results in dessication of riparian vegetation (Sogge *et al.* 1997). The presence of livestock, range improvements such as waters and corrals, and agriculture provide feeding areas for cowbirds. These feeding areas, if near

riparian habitats, coupled with habitat fragmentation, facilitate cowbird parasitism of flycatcher nests (Tibbitts *et al.* 1994, Hanna 1928, Mayfield 1977). After five years of cowbird trapping on the South Fork of the Kern River, California, nest parasitism rates dropped from 65 to 22 percent, nest success increased from 28 to 43 percent, and mean number of young fledged per female flycatcher increased from 1.04 to 1.72 (Whitfield *et al.* 1998).

In Arizona in 1998, 404 resident willow flycatchers were detected at 48 sites on 12 drainages. A total of 179 paired flycatchers were found at 40 sites. Major concentrations of birds were found near the confluence of the Gila and San Pedro rivers; Roosevelt Lake; the lower Grand Canyon; from Fort Thomas to Solomon on the middle Gila River; Topock Marsh on the lower Colorado River, Verde River at Camp Verde, near Greer and Alpine; and Alamo Lake on the Bill Williams River (Paradzick *et al.* 1999). Willow flycatcher nesting attempts in Arizona in 1999 totaled 250, of which outcome of the nest was determined for 230. Of the 230 nests, an estimated 261 flycatchers fledged. Cowbird brood parasitism occurred at 14 nests, however, five of these fledged flycatchers despite parasitism. Twenty-eight nests were either deserted or abandoned (Paradzick *et al.* 1999).

For further information on the ecology, range, status, and threats to this subspecies, refer to Brown (1988), Harris (1991), Harris *et al.* (1987a&b), McCarthey *et al.* (1988), Paradzick *et al.* (1999), Paxton *et al.* (1996), Sferra *et al.* (1997), Sogge *et al.* (1997), Stoleson and Finch (1998), Tibbitts *et al.* (1994), Unitt (1987), and Uyehara *et al.* (1998).

ENVIRONMENTAL BASELINE

Riparian habitat suitable for nesting southwestern willow flycatchers is generally lacking at Fort Huachuca. Duncan (in SAIC 1998a) reported a small patch of marginal habitat (no more than 10 acres of cottonwoods and wetland vegetation) on the West Range near Highway 90 just north of the main gate; however, further analysis suggested the site may not be suitable habitat (J. Hessil, pers. comm. 1999). Avian surveys have not been conducted at the site. This patch of riparian woodland burned in May 1999. The riparian vegetation is likely to recover and may develop into potential habitat after several years. Marginal habitat for flycatchers may also occur on-post at Gravel Pit Pond and Middle Garden Canyon Pond.

The upper San Pedro River from the Hereford Bridge downstream to the Interstate 10 bridge at Benson is designated critical habitat for the flycatcher. In 1996, flycatchers were found on the upper San Pedro near St. David, and in 1997, one flycatcher nest was found near Kingfisher (or Young-Block) ponds in the San Pedro RNCA near the Highway 90 crossing (McCarthey *et al.* 1998), however it was abandoned in July. A dead cowbird chick was found in the abandoned nest (SAIC 1998a). Early in the season, two territorial males were found upstream, and one was downstream of Kingfisher ponds (T. McCarthey, AGFD, pers. comm. 1997). SAIC (1998b)

conducted flycatcher surveys along 17.1 miles in six reaches of the upper San Pedro River in May-July 1997. Surveys were conducted according to Service protocol in five of the six reaches. No flycatchers were detected during these surveys. In 1998, one flycatcher was detected at Kingfisher ponds on June 8, but it is unknown if this bird was a migrant or a breeding bird. An apparent migrant was seen on June 4 at Hereford Bridge, but was not observed in subsequent surveys (Paradzick *et al.* 1999). Also in 1998, three territorial males were found on the San Pedro River at Apache Powder Road, just north of the San Pedro River RNCA, but it is not known if these birds were paired or if nests were present (T. McCarthy, pers. comm. 1998). In 1999, two willow flycatchers, probably migrants, were detected in late May and early June at Kingfisher Ponds (T. McCarthy, pers. comm. 1999). Comprehensive surveys for the species have not been conducted on the upper San Pedro River. A wildfire just north of the Highway 90 bridge destroyed 780 acres of riparian woodlands and grasslands in late May and June 1998. The fire was just downstream of where flycatchers were found in 1997. Another fire, apparently caused by a downed power line, burned approximately 800 acres in the RNCA in March 1999.

Critical habitat has also been designated on 66 miles of the lower San Pedro River from the gaging station near Aguaja Canyon downstream to the Gila River confluence. The area is relevant to this consultation because of the groundwater pumping issue, described in detail in the Environmental Baseline and Effects of the Proposed Action for the Huachuca water umbel. If flows and discharge to the upper San Pedro River decline due to the effects of the Fort's activities, reduced flows could be reflected downstream in the lower San Pedro River, as well (discussed in detail in the following Effects of the Proposed Action). The lower San Pedro River is one of the most important sites for the southwestern willow flycatcher. Eighty-four resident southwestern willow flycatchers (38 pairs) were found on the lower San Pedro River in 1998. A total of 107 flycatchers were known to fledge from nests on the lower San Pedro River in 1998 (Paradzick *et al.* 1999). In 1997, flycatchers nested primarily in saltcedar on the lower San Pedro River, but a few nests were found in buttonbush and willow (McCarthy *et al.* 1998). A reasonable and prudent alternative in the Service's biological opinion to the Bureau of Reclamation on proposed modifications to Roosevelt Dam required Reclamation to acquire and protect habitat for the flycatcher. In response, Reclamation provided a grant to the Nature Conservancy to acquire and manage an 820-acre site encompassing riparian habitat near Dudleyville, downstream of the Aravaipa confluence. This site, known as the San Pedro River Preserve, is part of a larger reach of the San Pedro, 11.3 miles in length - from the Gila River confluence to about 1.5 miles south of the Aravaipa confluence - that supports a rich and diverse riparian community and includes all of the important flycatcher sites on the lower river.

The relatively few southwestern willow flycatchers on the upper San Pedro River as compared to the lower San Pedro may be a result of the relatively narrow corridor of riparian forest; a lack of understory in most areas, and a history of grazing that probably reduced understory foliage density on the upper San Pedro River. In addition, saltcedar, which is an important nesting

substrate on the lower San Pedro, is relatively scarce on the upper San Pedro River. Since removal of most cattle after establishment of the RNCA, apparent foliage density in the understory has been increasing, with resulting increasing quality of flycatcher habitat. If this trend continues more flycatchers will likely be found in the RNCA. The upper San Pedro River may serve as a migration corridor for some birds moving between wintering grounds in Latin America and the lower San Pedro or other sites to the north; however, Skagen (1995) recorded no willow flycatchers on the upper San Pedro River during April and early May 1989-1994, and few flycatchers were detected during surveys from 1996 to the present (see summary above).

The Babocomari River has not been well surveyed for southwestern willow flycatchers; however, most of the habitat on the river is probably unsuitable due to intermittent flows and lack of sufficient riparian vegetation cover (Dave Krueper, BLM, Sierra Vista, AZ, pers. comm. 1998). Lack of permanent flow and suitable riparian vegetation downstream of Huachuca City is attributable to groundwater pumping by Huachuca City, Fort Huachuca, and Sierra Vista (Schwartzman 1990). However, information is inadequate to determine if this reach of the river might be suitable flycatcher habitat if groundwater pumping ceased. The Babocomari Cienega, located on the Babocomari River upstream of Huachuca City at the Babocomari Ranch, may have potential to support nesting southwestern willow flycatchers (D. Krueper, pers. comm. 1998). The area consists of an impoundment, possibly an impounded spring, surrounded by a healthy stand of cottonwoods, and farther upstream, a thick stand of short willows (Susan Skagen, USGS, Biological Resources Division, pers. comm. 1998). Avian surveys from April 3 to May 14 over a four year period (1989, 1991, 1993, 1994) resulted in no observations of willow flycatchers (Skagen 1995), but southwestern willow flycatchers do not begin building nests until late May. Riparian woodlands above and below the cienega consist mostly of decadent, old cottonwoods and a relatively low proportion of foliage density in the understory. This may reflect a lack of recruitment possibly due to heavy grazing that occurs in the area (Skagen 1995; S. Skagen, pers. comm. 1998). However, a decline in groundwater elevation could have the same effect on cottonwood demographics. The cienega is occupied by the Canelo Hills ladies'-tresses, discussed in the "Concurrences" section of this document.

Cowbirds readily fly up to four miles between feeding and breeding areas (Rothstein and Verner 1984) and are capable of daily movements of more than five miles (Cook *et al.* 1997). Livestock and livestock handling facilities tend to attract brown-headed cowbirds, leading to a greater incidence of nest parasitism than would otherwise occur. Grazing and pastures create bare ground and open areas preferred by cowbirds. Brown-headed cowbirds, historically associated with bison, have adapted to expansion of agriculture and have experienced rapid population growth and range expansion in this century (Lowther 1993). Approximately 50-60 horses are grazed on three pastures, totaling 1,433 acres, located northwest of the cantonment area of Fort Huachuca. Horses are grazed on the pastures from March to October. During the winter and early spring the horses are maintained in a corral in the same area. The pastures are located approximately 11-13 miles west of the San Pedro River, six miles southeast of the

Babocomari Cienega, and approximately four miles from the cottonwood stand reported by Duncan (1997 in SAIC 1998a) as marginal flycatcher habitat. The Fort has monitored the pastures on several occasions for cowbirds, but only one transient bird was observed (SAIC 1998a). Brown-headed cowbirds were common at the Babocomari Cienega and on the upper San Pedro River in April and May 1989-1994 (Skagen 1995) and on the upper San Pedro River in May and June 1997 (SAIC 1998b). McCarthy *et al.* (1998) report that brown-headed cowbirds were present at the flycatcher localities on the upper San Pedro River in 1997; and the one nest in 1997 was parasitized by cowbirds (SAIC 1998a). In 1998, as part of the reasonable and prudent alternative for the Roosevelt Dam biological opinion, the Bureau of Reclamation issued a contract for operation of two cowbird traps on the upper San Pedro River to reduce cowbird populations. A total of 164 cowbirds were trapped from April 1-July 31, 1998, at the two traps (Susan Sferra, Bureau of Reclamation, Phoenix, AZ, pers. comm. 1998).

Sections on hydrology in the Environmental Baseline for the Huachuca water umbel are included here by reference.

EFFECTS OF THE PROPOSED ACTION

Effects of the proposed action can be segregated into two parts: effects of groundwater pumping, and effects of training activities. Discussions of the former follow closely from the effects described for the Huachuca water umbel and include important indirect, interrelated/interdependent, and cumulative effects. Effects of training activities are fairly minor because no flycatchers have been found on the Fort, the potential to find breeding flycatchers on the Fort is very low, and training has minimal potential to affect habitat or flycatchers along the San Pedro River.

Effects of Groundwater Pumping

Portions of the Effects of the Proposed Action for the Huachuca water umbel pertinent to groundwater pumping are included here by reference. The following conclusions can be drawn from that discussion:

1. Annual low flows have declined on the upper San Pedro River at the Charleston and Palominas gages since 1942 or earlier (Koehler and Ball 1998, Corell *et al.* 1996, Jackson *et al.* 1987, Geraghty and Miller, Inc. 1995). From 1987-1994, low flows or periods of no flow became more frequent on the San Pedro River at Hereford, Charleston Bridge, and Fairbank. Inflows below Lewis Springs are diminished as a percentage of flows at Charleston gage (Sharma *et al.* 1997). Groundwater declines of

three to six feet have occurred at Palominas and Contention, respectively, since 1987 (ADWR 1994).

2. Groundwater decline is reducing recruitment of cottonwoods, resulting in a loss of obligate and facultative wetland plants, saltcedar is apparently replacing cottonwood on young floodplains at Contention (ADWR 1994), and during July, 1997, the river just north of the Charleston Narrows was dry and cottonwoods there were stressed, apparently due to lack of water (SAIC 1998b).

3. Currently, groundwater use in the Sierra Vista subwatershed exceeds supply by roughly 7,000 acre-feet per year (San Pedro Expert Study Team 1999). As a result of groundwater overdraft, a cone or cones of depression in the groundwater aquifer have formed under Fort Huachuca and Sierra Vista that are approximately 7.5 square miles in size and up to 90 feet deep. The cone(s) of depression has probably not reversed the flow of groundwater to the San Pedro River, but it captures mountain front recharge that otherwise would flow to the river and has likely reduced the hydraulic head adjacent to the river (Fenske 1998, ASL 1995, ADWR 1991, 1994). The cone of depression has affected flow patterns in the Babocomari River in the vicinity of northern Huachuca City and the Fort, where baseflow is severely depleted or absent during the dry season (Schwartzman 1990).

4. Possible causes of observed declines in baseflow on the San Pedro River include: 1) changes in runoff from the watershed due to changes in watershed condition, 2) influences of near-stream groundwater pumping for agricultural purposes, 3) changes in water use in Mexico, 4) changes in riparian vegetation along the river, and 5) groundwater pumping from the regional aquifer (ASL 1994, Jackson *et al.* 1987). Jackson *et al.* (1987), Sharma *et al.* (1997), and MacNish (1998) believe that groundwater pumping outside of the RNCA, particularly in the Hereford/Palominas area, is the most important causal factor in observed declines in baseflow. The San Pedro Expert Study Team (1999) believe the Fort Huachuca/Sierra Vista cone of depression began reducing the hydraulic head at the river in the 1960s or 1970s; while MacNish (1998) presents evidence that baseflow in the Lewis Springs to Charleston reach began declining due to the cone of depression about 1990. The importance of the Fort Huachuca/Sierra Vista cone of depression as a causal factor in current observed baseflow declines is uncertain (Koehler and Ball 1998, Fenske 1998, ASL 1994, ADWR 1991); however, modeling by Water and Environmental Systems Technology, Inc. (1996) suggested municipal and military users were only responsible for six percent of the historic loss of river flow through 1988.

5. Groundwater modeling efforts suggest that if groundwater pumping in the Fort Huachuca/Sierra Vista area has not yet significantly affected flows, it is predicted to do so in the very near future unless those effects are mitigated. Reaches of the San Pedro River could become intermittent where perennial flows now occur, and groundwater elevation under the river could decline (see Table 3). The reach from Charleston north past the Babocomari confluence is most at risk, followed by the reach from Highway 90 to Charleston. Because of a clay deposit under at least some portions of the river, future changes in baseflow in the reach from Hereford to Highway 90 will probably be linked more to the future of irrigated agriculture in the area than effects of the Fort Huachuca/Sierra Vista cone of depression. In the absence of a concerted effort to reverse current trends, the most likely future scenario is one of continued water use in excess of supply, continued enlargement of the cone of depression under Fort Huachuca and Sierra Vista, and in time dewatering of portions of the San Pedro River in the Sierra Vista subwatershed. An effluent recharge project to be developed by the City of Sierra Vista and Bureau of Reclamation is expected to delay the effects of pumping and the cone of depression on river baseflow, perhaps as long as 2020. However, uncertainties about how a clay deposit may affect recharge, and uncertainties surrounding future conditions and the feasibility of recharging effluent over the long term make it difficult to accurately predict how well and for how long the project will delay those effects. As long as water use exceeds supply, the riparian habitats and baseflow of the San Pedro River are threatened. In the long-term, if the cone of depression continues to grow, baseflows and groundwater elevation under the San Pedro River are expected to decline, with associated loss of wetland and riparian vegetation and changes in species composition (see Table 3, ADWR 1994, Stromberg *et al.* 1996).

6. Many viable water management options exist to mitigate the effects of groundwater withdrawals, and many have been implemented or are in the planning stages. However, prompt development and implementation of a comprehensive strategy to limit pumping and increase recharge is crucial to offset the current deficit and projected increased water demands in the subwatershed (see Effects of the Action for the Huachuca water umbel.)

Where the effects of the proposed action for the flycatcher depart from that of the water umbel is in regard to timing of the effects. The water umbel is a semi-aquatic obligate wetland plant. This group of plants would be the first to be adversely affected by declining flows (ADWR 1994, Stromberg *et al.* 1996). The southwestern willow flycatcher and its habitat could probably sustain small declines in groundwater elevation or flow in most areas, and thus would not be affected as rapidly as the water umbel. Also, flycatchers exhibit nest site fidelity (Sogge *et al.* 1997), and may return to a site to nest even though the habitat has declined or is degraded.

Southwestern willow flycatchers nest in dense riparian vegetation typically near surface water or saturated soil. In low elevation sites in Arizona (includes the upper San Pedro River), nests are most often found in nonnative saltcedar. However, only 15 percent of nests monitored in 1997 were located in monotypic stands of nonnative species. Although nests are typically placed in saltcedar, often other native tree species, such as cottonwood and willow are present (Paradzick *et al.* 1999, McCarthy *et al.* 1998, Sogge *et al.* 1997). As summarized above, flows have declined, recruitment of cottonwoods has been affected, and saltcedar may be replacing cottonwood in some areas. Further changes in southwestern willow flycatcher habitat on the lower San Pedro River could result if groundwater pumping in excess of recharge continues. Declining water tables have a disproportionate effect on obligate riparian trees, such as cottonwood and willows, which depend on relatively shallow groundwater (Snyder *et al.* 1998, Busch *et al.* 1992). Stromberg *et al.* (1996) predicted that groundwater declines on the San Pedro River of one and three feet would result in 37 and 51 percent declines, respectively, in potential habitat for juvenile Goodding willow, *Salix gooddingii*. Declines of six feet would eliminate seedling recruitment sites for cottonwood and willow (ADWR 1994). Groundwater declines of this magnitude have been observed at Palominas and Contention (ADWR 1994). Habitat of plants characteristic of deep groundwater (i.e. velvet mesquite, *Prosopis velutina*, hackberry, *Celtis reticulata*, and sacaton, *Sporobolus contractus*) and upland species (i.e. catclaw acacia, *Acacia greggii*, and rabbitbrush, *Chrysothamnus nauseosus*) was predicted to increase with increasing depth to groundwater (Stromberg *et al.* 1996). Under continuing groundwater decline, cottonwood and willow establishment would become restricted to the bottom of the river channel in a narrow band, followed by elimination of recruitment and decline of existing stands (ADWR 1994).

Based on the observation that saltcedar is replacing cottonwood in areas of groundwater decline of approximately six feet (ADWR 1994), cottonwood and willow communities could change to a community with young stands of salt cedar in the understory with an aging stand of mature cottonwoods and willows in the canopy. Under this scenario, the vegetation structure could still be adequate for southwestern willow flycatchers, depending on the height and density of the resulting salt cedar stands. However, if groundwater declined six feet, surface flows would likely become intermittent. Periods of no flow would be most likely to occur in May to early July when birds would be establishing territories and nesting. Lack of surface water would likely make these areas less suitable or unsuitable for nesting flycatchers. Increasing periods of no flow in early summer were discussed in the Effects of the Proposed Action for the Huachuca water umbel. Relatively small declines in groundwater elevation would result in increased periods of no flow first where flows are currently very low or occasional periods of no flow already occur, such as at the Tombstone gage (see discussion for Huachuca water umbel). At Lewis Springs, near where flycatchers were found in 1997, flows are approximately 40 percent of those at the Charleston gage, but a lack of no flow records suggests flycatcher habitat at this site might be more resilient to groundwater decline than at Hereford or Tombstone gage.

In the long-term, if groundwater use continues in excess of supply, the cone of depression under Fort Huachuca and Sierra Vista will continue to grow and will capture an increasing percentage of the groundwater (including effluent recharge) that otherwise would flow into the floodplain aquifer and the San Pedro River. As the cone of depression spreads towards the river it would cause gaining reaches to become losing reaches and result in further groundwater declines. Based on Don Pool's recent work and the presence of a clay deposit, baseflow near the Babocomari confluence may be affected first. The perennial reach upstream from the Babocomari confluence to Charleston may be the next reach affected, followed by the reach from Highway 90 to Charleston. The City's effluent recharge project is expected to delay the effects of pumping by bolstering baseflow from at least Highway 90 to Fairbank (ASL 1998), but the length of time the project will be effective at masking those effects is uncertain. In time, if groundwater withdrawals continue to exceed supply, groundwater elevation and baseflow are expected to decline enough to eliminate surface flow except during storm runoff, eliminate recruitment of cottonwood, willow, and saltcedar, and ultimately result in the death of obligate wetland plants (ADWR 1994, Stromberg *et al.* 1996). Cottonwoods and willows typically do not grow where groundwater is deeper than about 8 feet (Anderson 1995). If groundwater declines of this magnitude occurred, mortality of cottonwoods and willows would be expected. Flycatcher habitat could be eliminated under this scenario (BLM 1998). Similar loss of cottonwood and willow riparian habitat has occurred on the upper Santa Cruz River as a result of declining groundwater elevation (Stromberg *et al.* 1996.)

The timing of when loss of habitat might occur is disputed. The San Pedro Expert Study Team (1999) believe flows have been affected by the Fort Huachuca/Sierra Vista cone of depression since the 1960s or 1970s; MacNish (1998) believes the cone began affecting the river about 1990; but modeling by Water and Environmental Systems Technology, Inc. (1996) estimated that municipal and military users were only responsible for six percent of the historic loss of river flow through 1988. Whether declines currently attributable to the Fort Huachuca/Sierra Vista cone of depression are currently great enough to adversely affect flycatcher habitat is unknown. ASL (1998), using MODFLOW and assuming a successful effluent recharge project as currently proposed, showed that baseflows in the reach from Lewis Springs to at least Fairbank may begin to decline significantly by 2020 (Table 3). Absent the proposed Sierra Vista/Bureau of Reclamation effluent recharge project, baseflow in the same reach begins to decline by 2000.

Very small declines in baseflow could turn perennial reaches of the river into intermittent reaches. Table 1 of San Pedro Expert Study Team 1999, which shows the 90 driest days within the last 10 years at Charleston, illustrates that declines of less than 0.1 cfs will result in intermittent flows in this dependably perennial reach. These periods of no flow would occur when flycatchers are selecting nest sites and breeding, and are particularly sensitive to changes in flow patterns.

Many measures to reduce water use and/or increase recharge are planned or have been implemented in the Sierra Vista subwatershed that have the potential to delay adverse effects in specific reaches. The likelihood that enough measures can or will be implemented soon enough to prevent declines in baseflow and loss of habitat will depend on adequate funding and technical feasibility of the measures (see discussion for the water umbel). As discussed for the Huachuca water umbel, under the most likely future scenario, threats to the baselows of the river, and thus habitats of the willow flycatcher will remain unless a concerted effort is made to manage water resources. The Service believes that solutions to this problem are available and feasible at this time. However, if programs are not implemented soon, halting the growth and spread of the cone of depression will be impractical or impossible, and dewatering of portions of the river through the critical habitat area in the subwatershed will be inevitable.

To address this problem, the Fort has committed to developing an Army Water Resources Management Plan and to participate in the development of a Regional Water Resources Plan with other water users in the subwatershed. The goal of the Army Water Resources Management Plan is to maintain the Army's mission at Fort Huachuca while protecting and maintaining populations of listed species and their habitats. The Army's goal for the Regional Plan is to maintain baseflows in the upper San Pedro River sufficient to sustain species and habitats protected by the Endangered Species Act. These plans would be developed over the next three years. A variety of teams and partnerships, such as the Upper San Pedro Partnership, the San Pedro Expert Study Team, Advisory Panel on the Upper San Pedro Initiative, recommendations of the Water Issues Group, as well as designation of the San Pedro River RNCA and negotiations on the ongoing Gila River adjudication all have provided direction, ideas, and incentive to protect the riparian resources of the upper San Pedro River. Taken together, they provide a framework for Fort Huachuca to work with other agencies, the City of Sierra Vista, and others to protect the flycatcher and its habitat on the San Pedro River. The Service believes the Fort will be successful in developing with others in the basin water management plans within three years that, when implemented, will protect the flycatcher and its habitat. If the City of Sierra Vista's effluent recharge project works as anticipated herein, effects to the river from groundwater pumping should be delayed long enough to devise and implement these plans before the flycatchers or riparian habitats are significantly affected.

As discussed in the Environmental Baseline, groundwater pumping at the Fort and by Sierra Vista may have degraded riparian woodlands on the Babocomari River downstream of Huachuca City (Schwartzman 1990). Continued groundwater pumping at current rates is predicted to result in groundwater declines of 5.8 to 11.5 feet in 50 years, and 8.6 to 20.5 feet in 100 years in an area of considerable riparian vegetation downstream of Huachuca City (Schwartzman 1990). These declines are large enough to prevent recruitment of cottonwoods and willows, and will likely result in death of mature riparian trees (ADWR 1994, Stromberg *et al.* 1996, Anderson 1995). Whether this area would have potential to support flycatchers absent groundwater pumping is unknown.

The Babocomari Cienega contains potentially suitable habitat for southwestern willow flycatcher, but no flycatchers have been recorded there. The cienega is considerably upslope and upstream of the wells at Fort Huachuca and Sierra Vista. Brenda Houser, USGS, Tucson, AZ (1998) investigated the geology and hydrology of the area. Probably the most important structure in regard to the hydrology of the area is an east-west fault on the north side of the Babocomari River that brings relatively impermeable Tertiary conglomerate and volcanic rocks on the south side of the river in contact with Paleozoic limestone and dolomite units on the north. Houser (1998) suggests that "groundwater from the Mustang Mountains on the north probably flows southward in fractures or solution channels in the Paleozoic and Mesozoic bedrock, and in the saturated zone of the gravelly upper Tertiary and Quaternary piedmont sediments. Where the water intersects the fractured zone of the fault, it would be forced upward along the more permeable fracture zone by the presence of impermeable conglomerate and volcanic rocks on the south side of the fault. The water would then flow along the base of Quaternary terrace gravel deposits until it intersects the ground surface on the north side of the Babocomari River and emerges as springs and seeps." ADWR (1991) also notes the presence of a volcanic dike in the area that apparently causes a pooling of groundwater and forces water to the surface forming cienega conditions. Trends in groundwater elevation have not been investigated; however Skagen (pers. comm. 1998) noted decadent stands of cottonwoods above and below the cienega where recruitment is apparently low due to livestock grazing, groundwater declines, and/or other factors. Although data is insufficient to make any conclusive statements, because the cienega is considerably upstream of wells at Fort Huachuca and the Sierra Vista wells, faulting and geology suggest much of the water in the area comes from the Mustang Mountains, a geological feature forces groundwater to the surface at this site, and the river flows from the west, it is unlikely that groundwater pumping by Fort Huachuca or Sierra Vista currently affects or would in the future affect riparian habitat at or near the cienega. If future groundwater pumping in excess of supply resulted in the cone of depression capturing groundwater inflow to the area, it would probably occur well after effects to the San Pedro River manifest.

As discussed in the Environmental Baseline, the lower San Pedro River is one of the most important sites for southwestern willow flycatchers and includes a 66 mile reach of critical habitat. The upper and lower reaches of the San Pedro River are hydrologically connected, so that effects in the upper basin could potentially affect flows and riparian habitat in the lower basin. Most of the San Pedro River from Benson northward is intermittent (ADWR 1991), thus flow between the basins occurs primarily as subsurface flow and flood flow. The reach from near the Aravaipa confluence downstream to the Gila River, where the most important flycatcher habitat exists, is described as intermittent by ADWR (1991), but perennial pools and river segments occur in adequate numbers to support fish populations. A perennial reach of about four miles in length occurs south of Redington where groundwater is forced to the surface by shallow hardrock. A perennial cienega habitat occurs at Cook's Lake approximately 1.5 miles downstream of the Aravaipa confluence (ADWR 1991).

Unmitigated groundwater pumping would be expected to affect the baseflow of the upper San Pedro River (Table 3). Flood flows are not affected by groundwater pumping. Flycatcher habitat in the lower basin is located primarily in the Winkelman subwatershed immediately upstream of the Gila confluence. Eighteen percent (7,054 acre feet) of the annual water volume that leaves the Sierra Vista subwatershed flows all the way to the Winkelmann subwatershed (ADWR 1991). But this includes flood flows; baseflow would be much less. Groundwater inflow across subwatershed boundaries in the lower San Pedro River is insignificant (ADWR 1991). Flow between subwatersheds might be greater if water use did not exceed water supply in the Sierra Vista subwatershed, but because of the presence of cones of depression it is unlikely that any increased water supply would result in significant increases in subwatershed outflow. Even if the entire deficit (7,000 acre feet) was discharged as outflow from the Sierra Vista subwatershed, only 1,260 acre feet (18 percent) would be expected to reach the Winkelmann subwatershed. Annual water supply to the Winkelman subwatershed is 73,760 acre-feet, thus under this scenario, eliminating the deficit in the Sierra Vista subwatershed and diverting all of the gain to subwatershed outflow would only cause no more than an approximate two percent increase in annual inflow into the Winkelmann subwatershed, under the most optimistic conditions. Although the effects of groundwater pumping in the Sierra Vista subwatershed on downstream southwestern willow flycatcher habitat are uncertain, the best information available suggests that currently these effects are probably small or negligible. Effects of future groundwater pumping are predicted to be insignificant because baseflow from the Sierra Vista subwatershed into the subwatershed where flycatcher habitat primarily occurs is very small and proposed regional and on-post water management planning are expected to protect baseflows in the Sierra Vista subwatershed.

Effects of Other Activities at Fort Huachuca

Activities other than groundwater pumping are not likely to cause significant adverse effects to the southwestern willow flycatcher or its habitat. Adverse effects are possible, but not likely to occur, as a result of wildfire ignited by military training that destroys flycatcher habitat or nests. Adverse effects could also potentially occur due to disturbance of flycatchers or habitat at ASA sites in the RNCA, and disturbance or loss of potential habitat near the main gate, at Gravel Pit Pond and Middle Garden Canyon Pond.

As discussed for the Huachuca water umbel, fires are infrequently ignited on the East Range as a result of training (Figure 7). Area ZULU is a live fire impact area where fires could ignite from ordnance delivery. However, fires on the East Range are typically small and fire breaks around ZULU and on the eastern boundary of the installation make it highly unlikely that a fire ignited on the East Range would spread to the San Pedro River. Live munitions could also conceivably stray off course into the RNCA and start a fire. However, fires have never spread from the East Range to the San Pedro River, and fires have never been ignited on the San Pedro due to stray weapons fire. The Service believes the chance of these events occurring

during the life of the project is insignificant. Chances of fire spreading from the northwestern boundary of the installation to the Babocomari Cienega is also unlikely due to the presence of Chihuahuan Desert scrub containing little fuel to carry fire between the installation boundary and the cienega.

If riparian woodland near the main gate recovers from the May 1999 fire, its future value as habitat for flycatchers is unknown. It may be too isolated from occupied habitat or may not develop adequate understory foliage density to support flycatchers. The Fort has proposed to survey for flycatchers at suitable habitats on-post. As this data is collected, a better analysis of effects resulting from on-post activities will be possible.

The Fort maintains 22 ASA sites within or on the boundaries of the San Pedro River RNCA (Figure 2). As described in the Description of the Proposed Action, ASA sites are where the capabilities of electronic systems are tested. ASA sites are located along road shoulders or previously disturbed sites. At each site typically one or two vehicles and four to six personnel would be deployed for no more than 11 days. Occasional exercises involve up to 20 vehicles, 50 support personnel, and 60 to 70 students. Vehicles sometimes are mounted with large antennae, or ground-mounted antennae up to 80 feet in height are erected. Sites are located adjacent to the San Pedro River at the Charleston Road and the Highway 82 and 90 crossings. Habitats immediately adjacent to the sites are unknown, but the Highway 90 crossing is near the flycatcher localities found in 1997. If flycatchers nest immediately adjacent to ASA sites, the birds could be disturbed by training activities, particularly during an exercise involving many vehicles and personnel. Cigarettes discarded by personnel could potentially cause a fire and destruction of flycatcher habitat. Although unlikely, flycatchers could also potentially fly into an antennae and be killed or injured. These effects are mitigated by the Fort's commitment to not use ASA sites within 300 feet of southwestern willow flycatcher habitat from April 1 to September 1 of each year and to take precautions at ASA sites adjacent to suitable habitat, but farther than 300 feet, to minimize the chance that a fire occurs (Appendix 1).

Cowbirds are not known to occur at the horse pastures (SAIC 1998a), and regional populations are not likely significantly enhanced by other activities at Fort Huachuca. If cowbirds are occasionally attracted to the horse corral, golf course, urbanized portions of the cantonment area, or other portions of the installation, any effects to regional cowbird populations and resulting increased parasitism is likely masked by farming and ranching activities off of Fort Huachuca. Although Skagen (1995) found cowbirds to be common on the upper San Pedro River and at the Babocomari Cienega, there does not appear to be a source population or significant attractant at Fort Huachuca which if eliminated would reduce regional cowbird populations and risks to flycatchers.

As discussed for the Huachuca water umbel, watershed condition on the East Range is degraded in a band, approximately two to three miles in width, that runs across the range from the northwest to the southeast. Degraded watersheds can cause increased surface runoff and sediment transport, and decreased infiltration of precipitation (Belsky and Blumenthal 1997, DeBano and Schmidt 1989, Gifford and Hawkins 1979). Potentially, degraded watershed conditions on the East Range could result in higher peak flows, lower low flows, and sedimentation or erosion of the San Pedro and Babocomari rivers. Such conditions could potentially lead to scouring of riparian vegetation or reduced flows during willow flycatcher breeding activity. However, studies by the Environment and Natural Resources Division at Fort Huachuca (1997a) indicate that most sediment eroded from the East Range is deposited along the east boundary and does not reach the San Pedro or Babocomari rivers. The lower-elevation portions of the San Pedro River watershed outside of Fort Huachuca are much degraded due to development, a long history of livestock grazing, and conversion of grasslands to shrublands. The effects of watershed degradation on the East Range are probably largely masked by these regional watershed problems along the San Pedro River. Limiting vehicles to existing routes and removal of grazing are important steps taken by Fort Huachuca to reduce watershed degradation. Additional measures are planned, such as revegetation, brush control, construction of structures to slow erosion and trap sediment, placement of waterbars along roads, and closure of unneeded routes (Fort Huachuca 1997a). Implementation is subject to available funding.

Indirect, Interrelated and Interdependent Effects

Groundwater Pumping

Indirect, interdependent and interrelated effects of groundwater pumping are the same as that described for the Huachuca water umbel. Summarizing from that discussion, employees, contractors and their dependents; businesses and their employees and dependents; and military retirees and their dependents that would not be in the Sierra Vista subwatershed but for the presence of Fort Huachuca use groundwater. Thus, the amount of groundwater pumped that is attributable to Fort Huachuca is probably more than what actually is withdrawn from wells on-post. The precise effect of the Fort on growth and water use in Sierra Vista and surrounding areas cannot be quantified. However, following from the discussion for the Huachuca water umbel, effects (direct, indirect, interrelated, and interdependent) attributable to Fort Huachuca include pumping of a minimum of 2,355 and a maximum of 8,300 acre feet per year from the Sierra Vista subwatershed. This represents 25-88 percent of all groundwater pumping in the subwatershed, which approximates the portion of the water budget deficit (currently 7,000 acre-feet per year) attributable to the Fort's activities. Rough estimates within that range attributable to Fort Huachuca are 5,121-5,802 acre feet per year (54-61 percent of the groundwater pumping that causes the deficit is attributable to the Fort). These estimate should be revised when additional information becomes available.

Other Off-Post Activities

As discussed for the Huachuca water umbel, development attributable to Fort Huachuca may result in watershed degradation (Wang *et al.* 1997). Urban development can adversely affect biotic integrity and habitat quality in adjacent riparian systems. Urbanization results in increased runoff, and resulting changes in flow regimes, water temperature, water quality, and channel morphology (Wang *et al.* 1997, Schueler 1994). These changes may affect recruitment and development of riparian woodlands that the southwestern willow flycatcher uses as nesting and foraging habitat.

Development in the subwatershed attributable to Fort Huachuca probably also contributes to increased recreational use of the RNCA and other areas of the San Pedro River corridor. Increased recreational use results in greater chance of fire, off-road vehicle damage to riparian habitats, and disturbance of flycatchers by recreationists.

Other Activities at Fort Huachuca

As discussed for the Huachuca water umbel, the Fort supplies support services for other DOD units. Many units also train at Fort Huachuca that originate at other installations or that train elsewhere. Support services provided to other DOD units, and off-post activities of training units are not considered interrelated and interdependent to the proposed action because they are basic DOD functions that would occur with or without the presence of Fort Huachuca.

Cumulative Effects

Groundwater Pumping

As discussed for the Huachuca water umbel, cumulative effects of groundwater pumping are even more important than indirect, interrelated, and interdependent effects. Although employment and effective population at Fort Huachuca is expected to remain fairly constant, the population of the Sierra Vista subwatershed is expected to increase from the 1990 estimate of 51,400 to 73,900 in 2030 (San Pedro Expert Study Team 1999). Because the Fort is not expected to grow, this increase cannot be attributed to the Fort; although it is not possible to predict how growth in the subwatershed might be affected if the Fort was not present. Nevertheless, it is clear that growth in the area and subsequent increases in water usage have achieved momentum that is separate from any influence Fort Huachuca might have. The projected growth in water consumption in the subwatershed and the resulting continued deficit between recharge and use despite mitigation measures pose the greatest threats to the southwestern willow flycatcher on the upper San Pedro River.

Of great concern is the potential for additional agricultural development and associated pumping of groundwater in the floodplain of the San Pedro River in either the U.S. or Mexico portions of the river. Extensive acreage exists in Mexico and on private and State lands within the U.S. portion of the watershed that could potentially be developed for agriculture (San Pedro Expert Study Team 1999). This may become less of a threat if initiatives to designate irrigable lands as irrigation non-expansion areas or if purchase of lands or easements from willing sellers are implemented. As discussed in the 'Environmental Baseline' a number initiatives and planning processes are underway at local, State, Federal, and international levels that are expected to reduce cumulative effects due to groundwater pumping in the upper San Pedro River basin.

Effects to Critical Habitat

Critical habitat for the southwestern willow flycatcher was designated on a 54-mile reach of the upper San Pedro River within the 100-year floodplain from near the Hereford Bridge downstream to the Interstate 10 bridge. Critical habitat was also designated on 66 miles of the lower San Pedro from near the mouth of Aguaja Canyon to the Gila River confluence (Service 1997b). Effects analyses for critical habitat must determine if the proposed action would destroy or adversely modify critical habitat. "Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical (50 CFR 402.02). The primary constituent elements identified as necessary for the survival and recovery of the southwestern willow flycatcher are (Service 1997b):

- (1) Space for individual and population growth,
- (2) food, water, air, light, minerals, or other nutritional or physiological requirements,
- (3) cover or shelter,
- (4) sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal, and
- (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of the species.

These constituent elements are provided or will be provided by dense thickets of riparian shrubs and trees (native and nonnative). This vegetation, by definition, occurs near rivers, streams, open water, cienegas, and other wetlands. Constituent elements include the riparian ecosystem within the 100-year floodplain, and includes areas where dense riparian vegetation is not present, but may become established in the future. Vegetation patches may be uniformly

dense throughout or occur as a mosaic of dense thickets interspersed with small openings, bare soil, open water, or shorter/sparser vegetation.

As discussed in the "Effects of Groundwater Pumping" and "Indirect, Interrelated and Interdependent Effects", if the effects of the proposed action are left unmitigated, dewatering and loss of riparian vegetation could occur in critical habitat from Highway 90 to downstream of the Babocomari confluence. The northern portion of the critical habitat closer to the Interstate 10 bridge, is probably more influenced by the St. David diversion and groundwater pumping at St. David and Benson than by effects of the action, but declining baseflows in the Sierra Vista subwatershed could conceivably reduce baseflow downstream in the Benson subwatershed, causing adverse effects to willow flycatcher habitat. The reach from Charleston north through the RNCA is at greatest risk, followed by the reach from Highway 90 to Charleston. An effluent recharge project, if successful, is expected to mitigate loss of baseflow in the reach from Highway 90 to at least Fairbank, perhaps for as long as through 2020.

In the long-term, if water use continues to exceed recharge, the cone of depression under Fort Huachuca and Sierra Vista will continue to grow, and in time more and more of the groundwater flow (including effluent recharge) will be diverted into the cone of depression, resulting in decreased groundwater flow to the river and declining baseflow. In the long-term, flows throughout the Sierra Vista subwatershed from Highway 90 through the RNCA and possibly beyond could be diminished as a result of the proposed action.

The value of constituent elements necessary for the species' survival and recovery would be appreciably diminished or lost if groundwater withdrawals are not mitigated. A total of 20.8 miles (Highway 90 north through the perennial reach) are most likely to be affected by groundwater pumping attributable to Fort Huachuca. The 20.8 miles represents 3.5 percent of the total 599 miles of critical habitat designated for the species. Evidence suggests that dewatering is already occurring, although the cause is unclear and may or may not currently be attributable to effects of the action (Koehler and Ball 1998, San Pedro Expert Study Team 1999, MacNish 1998, SAIC 1998b, Fenske 1998, Sharma *et al.* 1997, ADWR 1994, ASL 1994). In the absence of a concerted effort to reverse current trends, the most likely future scenario is one of continued water use in excess of supply as a result of the proposed action, continued enlargement of the cone of depression under Fort Huachuca and Sierra Vista, and in time dewatering of portions of the San Pedro River in the Sierra Vista subwatershed and associated loss of critical habitat. Cumulative effects, particularly groundwater pumping not attributable to Fort Huachuca and the potential for development of new irrigated agriculture in the basin, further threaten the critical habitat of the southwestern willow flycatcher in the project area. Activities at Fort Huachuca other than groundwater pumping have a much lower probability of adversely affecting critical habitat (see "Effects of Other Activities at Fort Huachuca").

As discussed above, the Fort has committed to on-post and regional planning that should result in maintaining constituent elements of willow flycatcher critical habitat. The City of Sierra Vista's effluent recharge project is expected to delay significant effects to the river long enough for plans to be developed and implemented to maintain San Pedro River baseflows and riparian habitats.

Effectiveness of Proposed Mitigation

The Fort is committed to implementing several very important mitigating measures that would significantly reduce adverse effects to the southwestern willow flycatcher and its critical habitat (see Appendix 1, and "Proposed Mitigation Measures"). Most of the southwestern willow flycatcher mitigation measures in Appendix B of the MOA (see Appendix 1) were initially recommended by the Service to the Army to reduce or eliminate take. They were adopted by the Fort as part of their proposed action. The Fort has established an administrative process for limiting adverse effects to listed species that includes a point of contact, training and education of personnel in endangered species issues and requirements, strict range management procedures, and development of an Integrated Natural Resources Management Plan and individual management plans for each listed species.

Mutual aid agreements with the Coronado National Forest and local governments, requirements to have fire suppression capability on site during training exercises, fire breaks, the ability to implement seasonal closures, and other authorities available to the Range Control Officer provide the capability to suppress or prevent wildfires. Measures recommended by Fort Huachuca (1997) are adequate to improve degraded watershed conditions on the East Range and thus reduce possible threats to habitat on the San Pedro River from training activities.

The Fort should be commended for implementation of many water conservation practices that have reduced water use in recent years (SAIC 1998a). Such practices could serve as models for other water users in the subwatershed. If proposed water management projects are implemented, water savings/recharge of up to 600 acre-feet per year could result, reducing net direct water use by the Fort to approximately 1,300 acre-feet per year. However, even if these measures are implemented, they would reduce, but not eliminate, the threat to the willow flycatcher and its critical habitat. Ultimately, as long as the water budget is in deficit, willow flycatcher populations and critical habitat are threatened.

The Fort has also committed to developing an Army Water Resources Management Plan and to participating in the development of a regional Water Resources Plan with other water users in the subwatershed. The goal of the Army Water Resources Management Plan is to maintain the Army's mission at Fort Huachuca while protecting and maintaining populations of listed

species and their habitats. The Army's goal for the Regional Plan is to maintain baseflows in the upper San Pedro River sufficient to sustain species and habitats protected by the Endangered Species Act. These plans would be developed over the next three years. A variety of teams and partnerships, such as The Upper San Pedro Partnership, The San Pedro Expert Study Team, Advisory Panel on the Upper San Pedro Initiative, as well as designation of the San Pedro River RNCA and negotiations on the ongoing Gila River adjudication, all have provided direction, ideas, and incentives to protect the riparian resources of the upper San Pedro River. Taken together, they provide a framework for Fort Huachuca to work with other agencies, the City of Sierra Vista, and others to protect willow flycatcher populations and critical habitat. The Service believes the Fort will be successful in developing a comprehensive Army Water Resources Management Plan and working with others to develop a regional plan within three years that will protect willow flycatcher populations and constituent elements of critical habitat. If the effluent recharge project works as predicted, effects to river from groundwater pumping will be delayed long enough to devise and implement these plans before the flycatcher or its critical habitat are significantly affected.

CONCLUSION

After reviewing the current status of the southwestern willow flycatcher, the environmental baseline for the action area, the effects of the Fort's activities, and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the southwestern willow flycatcher and is not likely to result in adverse modification or destruction of critical habitat. We present these conclusions for the following reasons:

1. The Fort has committed to develop an Army Water Resources Management Plan and to work with others to develop a regional Water Resources Plan. The goal of the Army Water Resources Management Plan is to maintain the Army's mission at Fort Huachuca while protecting and maintaining populations of listed species and their habitats. The Army's goal for the Regional Plan is to maintain baseflows in the upper San Pedro River sufficient to sustain species and habitats protected by the Endangered Species Act.
2. The Bureau of Reclamation and City of Sierra Vista are developing an effluent recharge project that is expected to delay effects to river baseflow and flycatcher habitats in a reach of the river that otherwise could be significantly affected very soon by groundwater pumping at Fort Huachuca and Sierra Vista. Although this project does not alleviate the long-term threat to flycatcher habitats on the San Pedro River, it is expected to provide time to develop and implement a plan to address those long-term threats before significant impacts manifest.

The Service's finding that the proposed action is not likely to jeopardize the continued existence of the southwestern willow flycatcher or result in adverse modification or destruction of critical habitat is based entirely on the successful and prompt implementation of Sierra Vista's effluent recharge project to avoid near-term impacts, and the Fort's commitment to develop and implement water resource planning to protect in the long-term the flycatcher and its habitat on the San Pedro River. If either the effluent recharge project or the water resources planning efforts are not implemented on schedule or do not reduce, eliminate, or delay adverse effects as predicted herein, then reinitiation of consultation is warranted and the Service would need to reevaluate its conclusions [50 CFR 402.16(b and c)].

The Service bases its biological opinion on the effects of the action (direct, indirect, interrelated, and interdependent effects), the cumulative effects, the environmental baseline, and the status of the species. If the Service and the Army reinitiate this formal consultation, then as was done herein, effects of groundwater pumping by all pumpers on the flycatcher and its critical habitat (including all cumulative effects) must be evaluated in determining whether the Army's actions jeopardize the species or results in adverse modification or destruction of critical habitat. An alternative to this scenario is for the Army to zero out its effects to the flycatcher and its critical habitat, or reduce them to such a level that they are insignificant or discountable (insignificant effects relate to the size of the impact and should never reach the scale where take occurs; discountable effects are those extremely unlikely to occur). In this case the Army could request a concurrence from the Service that their proposed action may affect, but is unlikely to adversely affect, the flycatcher and its critical habitat [50 CFR 402.14(b)]. In evaluating whether or not to concur with such a request, the Service does not consider cumulative effects.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Harass is defined in the same regulation by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take of a listed animal species that is incidental to, and not the purpose of, the carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of sections 7(b)(4) and 7(o)(2) of the Act, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited

taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

AMOUNT OR EXTENT OF TAKE

The likelihood that take of willow flycatcher will occur as a result of the proposed action is very low due to the Fort's "Proposed Mitigation Measures", described in the proposed action, and commitments in the MOA. Thus, no take of southwestern willow flycatcher as a result of the proposed action is anticipated or authorized.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information on listed species. The recommendations provided here do not necessarily represent complete fulfillment of the agency's section 2(c) or 7(a)(1) responsibilities for the southwestern willow flycatcher. In furtherance of the purposes of the Act, we recommend implementing the following actions:

1. The Fort should support basic research and monitoring of the southwestern willow flycatcher in the San Pedro River basin, including determining the status of the species in the Mexican portion of the basin, rates of cowbird parasitism, benefits of cowbird trapping, development of a quantitative model defining suitable habitat of the willow flycatcher on the San Pedro River, and other topics.
2. In the proposed mitigation measures, the Fort has proposed to assist the BLM and other land owners with habitat management or restoration of flycatcher habitat that has been degraded. Off-post projects that the Fort should consider funding include contacting the landowner at the Babocomari Cienega to inquire if the Fort can assist in riparian restoration at that site, and restoration or protection of riparian woodlands on the upper or lower San Pedro River, if approved by and coordinated with the landowner(s).
3. The Army's Water Resources Management Plan should adopt an objective of balancing groundwater withdrawals with recharge on Fort Huachuca by 2009.

4. The Fort should recognize and support the need to balance water use with water supply in the Sierra Vista subwatershed and encourage other water users in the subwatershed to endorse, through the regional water resources planning effort, this goal.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of the conservation recommendation.

(Note: survey for Southwestern willow flycatchers via tape-recorded calls requires appropriate permits from Arizona Game and Fish Department and the Service.)

Mexican Spotted Owl

STATUS OF THE SPECIES

The Mexican spotted owl was proposed for listing on November 4, 1991 (56 CFR 56344) and was listed as threatened on March 16, 1993 (58 FR 14248). Critical habitat was designated for the species on June 6, 1995 (60 FR 29914), but was withdrawn in a recent Federal Register notice (63 FR 14378). No lands at Fort Huachuca or in the Huachuca Mountains were designated critical habitat in the 1995 final rule. The Mexican spotted owl was originally described from a specimen collected at Mount Tancitaro, Michoacan, Mexico, and named *Syrnium occidentale lucidum*. The spotted owl was later assigned to the genus *Strix*. Specific and subspecific names were changed to conform to taxonomic standards and the subspecies became *S. o. lucida*. The American Ornithologists' Union currently recognizes three spotted owl subspecies, including the California, *S. o. occidentalis*; Mexican, *S. o. lucida*; and Northern, *S. o. caurina*. The Mexican spotted owl is mottled in appearance with irregular white and brown spots on its abdomen, back, and head. The spots of the Mexican spotted owl are larger and more numerous than in the other two subspecies giving it a lighter appearance. Several thin white bands mark an otherwise brown tail. Unlike most owls, spotted owls have dark eyes.

The Mexican spotted owl is distinguished from the California and Northern subspecies chiefly by geographic distribution and plumage. The Mexican spotted owl has the largest geographic range of the three subspecies. The range extends from the southern Rocky Mountains in Colorado and the Colorado Plateau in southern Utah southward through Arizona and New Mexico and, discontinuously through the Sierra Madre Occidental and Oriental to the mountains at the southern end of the Mexican Plateau.

Using starch-gel electrophoresis to examine genetic variability among the three subspecies of spotted owls, Barrowclough and Gutierrez (1990) found the Mexican spotted owl to be

distinguishable from the other two subspecies by a significant variation, which suggests prolonged geographic isolation of the Mexican subspecies and indicates that the Mexican spotted owl may represent a species distinct from the California and Northern spotted owls.

The current known range of the Mexican spotted owl extends north from Aguascalientes, Mexico through the mountains of Arizona, New Mexico, and western Texas, to the canyons of southern Utah and southwestern Colorado, and the Front Range of central Colorado. Although this range covers a broad area of the southwestern United States and Mexico, much remains unknown about the species' distribution within this range. This is especially true in Mexico where much of the owl's range has not been surveyed. Information gaps also appear for the species' distribution within the United States. It is apparent that the owl occupies a fragmented distribution throughout its United States range corresponding to the availability of forested mountains and canyons, and in some cases, rocky canyon lands.

The primary administrator of lands supporting owls in the United States is the Forest Service. According to the Recovery Plan, 91 percent of owls known to exist in the United States between 1990 and 1993 occur on land administered by the Forest Service (Service 1995b). The majority of known owls have been found within Region 3 of the Forest Service, which includes 11 National Forests in New Mexico and Arizona. Forest Service Regions 2 and 4, including two national forests in Colorado and three in Utah, support fewer owls.

The range of the Mexican spotted owl in the United States has been divided into six recovery units (RUs) as discussed in part II.B. of the Recovery Plan for the Mexican Spotted Owl (Recovery Plan) (Service 1995b). An additional five RUs were designated in Mexico. While the Recovery Plan provides distribution, abundance, and density estimates by RU, a reliable estimate of the numbers of owls throughout its entire range is not currently available due to limited information. Owl surveys conducted from 1990 through 1993 indicate that the species persists in most locations reported prior to 1989, with the exception of riparian habitats in the lowlands of Arizona and New Mexico, and all previously occupied areas in the southern states of Mexico. Increased survey efforts have resulted in additional sightings for all recovery units.

Fletcher (1990) calculated that 2,074 owls existed in Arizona and New Mexico in 1990 using information gathered by Region 3 of the Forest Service. Fletcher's calculations were modified by McDonald *et al.* (1991), who estimated that there were a total of 2,160 owls in the United States. Ganey (1998) estimates 600-1,200 Mexican spotted owls inhabit Arizona. However, these numbers are not reliable estimates of current population size for a variety of statistical reasons. While the number of owls throughout its range is currently not available, the Recovery Plan reports an estimate of owl sites based on 1990 - 1993 data. An owl "site" is defined as a visual sighting of at least one adult owl or a minimum of two auditory detections in the same vicinity in the same year. Surveys from 1990 through 1993 indicate one or more

owls have been observed at a minimum of 758 sites in the United States and 19 sites in Mexico. The greatest concentration of known owl sites in the United States occurs in the Upper Gila Mountain (55.9 percent), followed by the Basin and Range-East (16.0 percent), Basin and Range-West (13.6 percent), Colorado Plateau (8.2 percent), Southern Rocky Mountain-New Mexico (4.5 percent), and southern Rocky Mountain-Colorado (1.8 percent) RUs.

Past, current, and future timber-harvest practices in Region 3 of the Forest Service, in addition to catastrophic wildfire, were cited as the primary factors leading to listing of the spotted owl as a threatened species. Fletcher (1990) estimates that 1,037,000 acres of habitat were converted from suitable (providing all requirements of the owl, e.g., nesting, roosting, and foraging) to capable (once suitable, but no longer so). Of this, about 78.7 percent, or 816,000 acres, was a result of human management activities, whereas the remainder was converted more or less naturally, primarily by wildfire. Other factors which have or may lead to the decline of this species include a lack of adequate regulatory mechanisms. In addition, the Recovery Plan notes that forest management has created ecotones favored by great horned owls, and there is, as a result, an increased likelihood of contact between spotted owls and great horned owls (a potential competitor and predator). Increases in scientific research, birding, educational field trips, and agency trips are also likely to occur. Finally, there is a potential for increasing malicious and accidental anthropogenic harm. Based on short-term population and radio-tracking studies, and longer-term monitoring studies, the probability of an adult Mexican spotted owl surviving from one year to the next is 0.8 to 0.9. Juvenile survival is considerably lower at 0.06 to 0.29, although it is believed these estimates may be artificially low due to the high likelihood of permanent dispersal from the study area and a period of several years before marked juveniles reappear as territory holders and are detected as survivors through recapture efforts (White *et al.* 1995). Little research has been conducted on the causes of mortality of the spotted owl, but predation by great horned owls, northern goshawks, red-tailed hawks, and golden eagles; starvation; and accidents or collisions may all be contributing factors.

Little is known about the reproductive output for the spotted owl. It varies both spatially and temporally (White *et al.* 1995), but the subspecies demonstrates an average annual rate of 1.001 young per pair. There is inadequate data at this time to estimate population trend. Little confidence in initial estimates has been expressed, and is due to its reliance on juvenile survival rates which are believed to be biased low, and due to the insufficient time period over which studies have been conducted.

A total of 213 projects have been formally consulted on in Arizona and New Mexico since August 1993. The Forest Service has consulted on 203 of these projects. In 74 of the biological opinions the Service anticipated incidental take of Mexican spotted owl. These projects have resulted in the anticipated incidental take of more than 153 owls.

Further information on the taxonomy, biology, and reproduction of the Mexican spotted owl can be found in the final rule listing the species as threatened and in the Recovery Plan.

ENVIRONMENTAL BASELINE

Fort Huachuca lies within the Basin and Range-West RU, as described in the Recovery Plan. This RU includes most of southern Arizona and a small portion of southwestern New Mexico. Owl territories occur in both heavily forested terrain and in areas with hardwood and conifer stringers dominated by Madrean Evergreen woodland. The subpopulation occurs in widely distributed territory clusters of varying sizes. The Sky Island Division (includes the Huachuca Mountains) may represent an important demographic link between the Mogollon Province demes and those in the Sierra Madre Occidental. Demographic persistence and connectivity within the Division and between divisions may be hindered by the compounding factors of naturally disjunct habitat and long dispersal distances.

The risk of habitat loss due to catastrophic wildfire is moderately high. In the past four years, the Noon, Arcadia, Clark Peak and Lone Fires have resulted in the loss of Mexican spotted owl habitat within this RU. A large, widespread fire in 1899 was the first of a series of stand-replacing fires in the Huachuca Mountains during the last century. Recent stand-replacing fires have occurred in the Huachuca Mountains in the vicinity of Carr Peak (1977) and Pat Scott Peak (1983) (Danzer 1997). Although the Coronado National Forest does not have an active timber program, localized projects in the Huachucas and other ranges in the Sky Island Division, such as road construction, mining, and other construction may adversely affect the owl or its habitat.

Within the Basin and Range-West RU, spotted owls have been located in rocky canyons or in several forest types at elevations ranging from 3,690 to 9,610 feet of the Atascosa-Pajarito, Santa Rita, Santa Catalina, Patagonia, Whetstone, Galiuro, Huachuca, Chiricahua, Pinaleno, Superstition, Sierra Ancha, Mazatzal, and Bradshaw Mountains, Arizona. Below 4,264 feet spotted owls were found in steep canyons containing cliffs and stands of live oak, Mexican pine, and broad-leaved riparian vegetation (Ganey and Balda 1989). Above 5,904 feet, spotted owls were found in mixed conifer and pine-oak forests. Mid-elevation observations included sites with Arizona cypress and the other forest types previously mentioned (Service 1995b).

Twenty spotted owl management territories are known from the Huachuca Mountains, including eight on Fort Huachuca and 12 on Coronado National Forest lands to the south of the Fort (Duncan 1999, Service files). Russell Duncan has monitored, banded, and taken blood samples from Mexican spotted owls on Fort Huachuca since 1990. Results of all known Mexican spotted owl surveys on Fort Huachuca are reported in Table 4. In 1996, SAIC (1998a) conducted, in accordance with Service protocol, surveys of all suitable habitat on the

South Range that did not contain previously identified spotted owl territories. No new territories were located. Approximately 16 percent of the South Range was classified as potential habitat. In 1997, surveys of potential habitats on Fort Huachuca were conducted four times. Duncan (1997) found breeding pairs of owls only in McClure and upper Huachuca canyons. A pair of owls in Scheelite Canyon did not breed in 1997. In 1998, Mexican spotted owls were detected in McClure, Upper and Lower Huachuca, and Scheelite canyons. Only the pair in Huachuca Canyon reproduced (Duncan 1999). Surveys are incomplete for 1999, but Service personnel observed a pair of spotted owls in Scheelite Canyon in late June, 1999. The Service's policy is that potential nest/roost habitat is considered inadequately surveyed if more than one breeding season has elapsed since the last year of survey to protocol. The Service therefore considers inadequately surveyed habitat to be occupied by Mexican spotted owl. Follow-up surveys consisting of an additional year of survey (4 visits) must occur prior to actions that may effect the owl or its habitat. Spotted owls have been detected at Fort Huachuca during winter in Tinker Canyon (Duncan 1993). They may be found at lower elevation sites in the Huachuca Mountains when not nesting.

Eight "protected area centers" (PACs) have been identified at Fort Huachuca (Table 4). PACs are nest sites, a roost grove commonly used during the breeding season in absence of a verified nest site, or the best roosting/nesting habitat if both nesting and roosting information are lacking. In the Basin and Range-West RU, PACs are based on owl management of PACs to ensure that all Mexican spotted owl sites known from 1989 through the life of the Recovery Plan are protected. PACs are areas of no less than 600 acres that enclose the best owl habitat in the area, with the nest or activity center near the center. Acreages of PACs at Fort Huachuca are not available. All eight PACs occur in the higher elevations of the Fort in the Huachuca Mountains.

EFFECTS OF THE PROPOSED ACTION

SAIC (1998a) lists noise, fire, human disturbance, and direct mortality as potential threats to spotted owls at Fort Huachuca. Owl territories and PACs are located in the canyons of the Huachuca Mountains where ground-based military training is limited primarily to existing routes of travel. Most human use of these areas is light and limited primarily to recreational pursuits such as birding, hunting, and hiking.

Recreational use in most canyons where territorial spotted owls have been recorded or that contain PACs is light because to reach these areas requires often considerable hiking over steep terrain. An exception is the PAC in Scheelite Canyon, which is well-known by birders as an easily accessible site to view Mexican spotted owls. Davis and Russell (1995) and Taylor (1995), popular birding guides for southeastern Arizona, provide directions to the site, and in the case of Taylor (1995), specific information on where the birds can be found. Most birders

visiting Scheelite Canyon stay on the trail, and are conscientious and unobtrusive. Viewing of spotted owls in this wooded canyon no doubt has value in terms of environmental education and awareness.

The response of wildlife to recreational disturbance is complex, and the effects are not immediately obvious or easily determined (Hammitt and Cole 1987; Flather and Cordell 1995). Evidence suggests that recreational activity can harm wildlife (Knight and Cole 1995). Tolerance levels for wildlife interactions with humans will vary by time of year, breeding season, age, habitat type, and individual experience with recreationists (Hammitt and Cole 1987). Human activities can impact wildlife directly through exploitation and disturbance, or indirectly through habitat modification and pollution. The Service's concerns with regards to the canyons in which owls are present include current and future recreation use and the potential direct effects to the Mexican spotted owl of disturbance and harassment, and to a lesser extent, the indirect effects of prey habitat modification. The Recovery Plan indicates that the determining factor of a recreational activity's impact on spotted owls is a combination of its location, intensity, frequency, and duration.

The physical characteristics of the side canyon may assist in providing topographic screening. Topographic screening between the area of disturbance and the birds location creates a noise buffer, and may assist in the reduction of noise disturbance (Knight and Cole 1995). But, the physical structure of canyons can also tend to magnify disturbances and limit escape/avoidance routes for owls (Service 1995b). Scheelite Canyon is a narrow, deep canyon with limited perching and roosting sites. The owls are typically perched close to the trail.

The Recovery Plan states that groups of 12 or more hikers or a steady stream of hikers occurring in narrow canyon bottoms may be especially disturbing to owls. The spotted owl breeding season, which extends from March 1 through August 31, is an especially popular time for birders and other recreationists to visit the Fort. In addition, during high use periods, large groups of hikers may use the trail, whether intentionally hiking in groups, or because groups are formed unintentionally due to hikers backed up behind each other. The Service believes the potential for disturbance to Mexican spotted owls in the PAC exists given the trail location relative to past owl locations, as well as the high recreational use level on the trail during the breeding season.

There are three learned responses wildlife may show to recreationists: habituation, attraction, and avoidance (Knight and Temple 1995). Recreational disturbance during the breeding season may affect an individual's productivity; disturbance outside the breeding season may affect the individual's energy balance and, therefore, its survival. Birds may respond to disturbance during the breeding season by abandoning their nests or young, by altering their behavior such that they are less attentive to the young, which increases the risk of the young being preyed upon, or by disrupting feeding patterns, or by exposing young to adverse environmental stress (Knight and Cole 1995).

Owls have more sensitive hearing than other birds (Bowles 1995). If a noisy sound source arouses an animal, it has the potential to affect its metabolic rate by making it more active. Increased activity can, in turn, deplete energetic reserves (Bowles 1995). Noisy human activity can cause raptors to expand their home ranges, but often the birds return to normal use patterns when the humans are not present (Bowles 1995). Such expansions in home ranges could affect the fitness of the birds, and thus their ability to successfully reproduce and raise young. Species that are sensitive to the presence of people may be displaced permanently, which may be more detrimental to wildlife than recreation-induced habitat changes (Hammitt and Cole 1987; Gutzwiller 1995; Knight and Cole 1995). If animals are denied access to areas that are essential for reproduction and survival, then that population will decline. Likewise, if animals are disturbed while performing essential behaviors such as foraging or breeding, that population will also likely decline (Knight and Cole 1995). There is also evidence that disturbance during years of a diminished prey base can result in lost foraging time which, in turn, may cause some raptors to leave an area or not to breed at all (Knight and Cole 1995).

There are no completed studies to date on the effects of recreational activities specific to the Mexican spotted owl. Research on all subspecies of the spotted owl indicate that it exhibits docile behavior when approached by researchers, and there is no clear evidence of significant impact by research activity except for a negative effect on reproduction from back-pack radio transmitters (Gutierrez *et al.* 1995). However, researchers purposefully make as little noise as possible, and disturbance is very limited in duration. In the long term, some species may become less responsive to human disturbance if they are not deliberately harassed; others may become very stress-prone towards humans (Bowles 1995; Hammitt and Cole 1987). Excessive interaction with humans may cause a lowering of call response rates or habituation; the effects of habituation on spotted owls are unknown (Gutierrez *et al.* 1995). Owls have been known to begin calling during the breeding season in response to the sound of human voices (M. James, Service, Flagstaff, pers. comm. 1998). Such behavior is likely characteristic of a certain percentage of individuals, and this response to humans may create a situation where these owls are discovered by hikers, thereby exposing themselves to potential direct impacts.

Ecologists suspect that spotted owls select habitats partially because of the availability of prey (Service 1995b). Ward and Block (1995) found that the reproductive success of the Mexican spotted owl was not influenced by a single prey species, but rather by many species in combination. Trails in riparian areas affect the soil and riparian vegetation adjacent to the trail, as well as the aquatic system itself. By directly impacting these components, recreationists affect an animal's food supply and availability as well as its habitat; in turn, impacts on food and habitat influence behavior, survival, reproduction, and/or distribution (Cole and Landres 1995). Impacts on soil include compaction of mineral soil, reductions in total porosity, reductions in infiltration rates, and increased soil erosion (Cole and Landres 1995). These changes in soil characteristics can adversely affect the germination, establishment, growth and reproduction of plants. Direct impacts to vegetation also comes from crushing and uprooting of vegetation. Consequently, recreation areas characteristically have vegetation that is less abundant (reduced

density and cover), of a reduced stature, and with different species composition from undisturbed areas (Cole and Landres 1995). Removal of living vegetation affects the habitat and food sources of small mammals (Hammit and Cole 1987) that comprise owl prey items. Recreationists may unintentionally start fires, for instance with discarded cigarettes, which could have a devastating effect on Mexican spotted owl habitat.

The owls in Scheelite Canyon appear to be mostly oblivious to human presence. However, there is some evidence of trampling and soil compaction off the trail and in recent years large groups of birders, apparently birding tour groups, have visited the canyon. Russell Duncan (pers. comm. 1998) reported a recent group of approximately 50 birders lead by a trip leader that was calling or hooting for owls in Scheelite Canyon. The Service requires a section 10(a)(1)(A) permit for use of tape recorded calls or hooting to locate Mexican spotted owls. The Service does not issue such permits for commercial or recreational viewing of listed species. Also, as discussed, a group of 50 individuals may be a large enough presence to elicit an alarm response or to otherwise harm or harass the spotted owls in Scheelite Canyon, or disturb habitat (Service 1995b). In December 1992, Duncan (1993) found an adult female spotted owl in Scheelite Canyon on the ground in a lethargic state. The bird was taken to a veterinarian in Tucson where it died after seven days. The cause of death was a pneumonia-like lung infection complicated by a subdermal hematoma probably caused by a blow to the back of the head. Duncan (1993) stated that a human-related cause of the hematoma can not be ruled out.

The Recovery Plan notes that birders and wildlife photographers actively seek spotted owls and are therefore more disruptive than the accidental encounters associated with other recreational activities. The Plan goes on to say that hooting for spotted owls or using mousing techniques to attract owls, if practiced to excess, may disrupt an owl's territorial, mating, and nesting activities (Service 1995b). The Plan finds that most owls appear to be relatively undisturbed by groups of people of 12 or less. In response to the Service's concerns and the recommendations of the Recovery Plan, the Fort has committed to posting a sign at the mouth of Scheelite canyon that informs visitors that groups are limited to 12 or less; calling, hooting, or playing taped recordings to elicit responses from owls is prohibited; and that visitors should stay on the trail and be as quiet and unobtrusive as possible (Appendix 1). This should reduce possible harassment or disruption of Mexican spotted owls in the canyon.

Rapelling or rock climbing on cliffs supporting active Mexican spotted owl nests could result in disturbance of nesting owls. Recreational rapelling and rock climbing are prohibited on Fort Huachuca; however, rapelling as part of military training occurs on cliffs in Garden Canyon. The rapelling cliff is located outside of current spotted owl PACs, and if owls are found nesting within 0.25 mile of the rapelling cliff, rapelling shall be moved at least 0.25 mile away during March 1 through August 31, or until nestlings fledge (Appendix 1).

Sources of noise other than those made by hikers or birders may also disturb spotted owls and include explosive ordnance discharge and delivery, discharge of firearms by hunters, small arms ammunition firing on the South Range, and aircraft overflights. Delaney *et al.* (1997) reviewed literature on the response of owls and other birds to noise and drew the following conclusions: 1) raptors are more susceptible to disturbance-caused nest abandonment early in the nesting season, 2) birds generally flush in response to disturbance when distances to the source are less than approximately 200 feet and when sound levels are in excess of 95 dBA, and 3) the tendency to flush from a nest declines with experience or habituation to the noise, although the startle response cannot be completely eliminated by habituation.

Small arms firing on the South Range could potentially disturb Mexican spotted owls. However, the firing ranges are all at least 2.4 miles from spotted owl PACs (Figure 4), and any noise from such firing that reaches the PACs is likely to attenuate well below 95 dBA. Artillery and mortar firing occurs at several areas on the East Range. Ordnance is directed eastward from these sites and is delivered into Area ZULU, also on the East Range. Noise from these sources is likely louder than the small arms firing on the South Range. However, mortar and artillery firing on the East Range occur at a much greater distance from owl territories. All mortar and artillery firing sites and the impact zone in Area ZULU are more than 7.1 miles from the nearest PAC. No effects to spotted owls are anticipated as a result of mortar and artillery firing on the East Range.

Hunting for big game, quail, and dove is allowed within spotted owl habitat at Fort Huachuca. Potentially, a hunter could discharge a firearm near a roosting or nesting spotted owl and cause an owl to flush or elicit a startle response. However, this type of disturbance is likely to be infrequent. Most hunting occurs during the fall and winter months, outside of the spotted owl breeding season.

PACs in training area P are within portions of the firing fan of tank gunnery range 12C. However, this firing range is currently not in use and, if proposed for use during the life of the project, would be the subject of separate consultation. PACs in training areas O and S fall within portions of firing ranges 12A&B and 9. Range 12B is a tank gunnery range that is currently not in use. As with 12C, if 12B is proposed for use, it would be the subject of separate consultation. Machine guns (.50 and 90mm caliber) and recoilless rifles are discharged at ranges 9. At Range 12A, .50 caliber, 7.62mm, and 40mm weapons are discharged. The PACs are in the upper reaches of the firing ranges, at least 2.4 miles from where weapons would be fired. Ordnance and shells would reach PACs only if the targets were overshot. The likelihood that ordnance or shells would strike a spotted owl or nest is highly unlikely, particularly because owls are typically in wooded canyons that would be sheltered from stray weapons fire. Occasional stray fire has much greater implications for igniting fire with its associated impacts, as discussed below.

Mortality or injury of Mexican spotted owls could also occur due to collisions with vehicles, aircraft, power/communications lines, or as a result of electrocution on powerlines. However, reports of such mortality are rare in Arizona. The Service believes mortality or injury from collisions or electrocution could possibly occur during the life of the project, but are unlikely.

Low-level flights are sometimes authorized over the canyons of the Huachuca Mountains where Mexican spotted owls nest. Fixed wing aircraft are generally limited to elevations of 500 feet above ground level (AGL) or higher, although Arizona Game and Fish Department is granted authority to fly lower to conduct wildlife surveys. Helicopter flights may occur at elevations below 500 feet AGL. UAV flights may also occur at low levels over the Huachuca Mountains. The Fort did not supply the Service with frequency or seasonality of low-level flights; however, based on experience of Service personnel, such flights are not frequent. During extensive wildlife and plant field work at Fort Huachuca, Russell Duncan (pers. comm. 1998) has not observed low-level fixed wing or helicopter flights in montane canyons, but has observed occasional UAV flying at low levels. The Fort has proposed to minimize low-level helicopter flights within one mile of active nests and would not authorize helicopter flights within 0.25 mile of an active nest (Appendix 1).

According to a "Report to Congress on Effects of Aircraft Overflights on the National Park System" (U.S. National Park Service 1994), wildlife respond to low-level aircraft overflights, although the manner in which they do so depends on life-history characteristics of the species, characteristics of the aircraft, flight activities, and a variety of factors such as habitat type and previous exposure to aircraft. The primary concern stemming from these low-level overflights related to wildlife are the physiological and/or behavioral responses caused by the flights. These responses may reduce the wildlife's fitness or ability to survive. Overflights may cause stress, and if chronic, stress can compromise the general health of the animal. Overflights may interfere with raising young, habitat use, and physiological energy budget. Indirect effects, such as accidental injury, energy loss, habitat avoidance and abandonment are very difficult to detect, but some experts suspect they occur (U.S. National Park Service 1994).

Studies that have investigated the effects of low-level aircraft overflights on birds have determined that such flights disturb raptors (Manci *et al.* 1987). Disturbances include interrupting nesting activities by flushing from nesting and roost, displacing birds returning to nests, flushing or displacing birds from foraging areas, provoking interactions with sympatric raptors, and exposing eggs and nestlings to predators and extreme heat. Studies have also suggested that human activities within breeding and nesting territories may affect raptors by changing home range movements (Anderson *et al.* 1990) and causing nest abandonment (Postovit and Postovit 1987, Porter *et al.* 1973). While these studies have not demonstrated a causal link between low-level overflights and reproductive success, they do document a level of disturbance that clearly is equivalent to harassment. Under section 9(a)(1)(B) of the Act, harassment is a form of take.

Compared to jets and light planes, helicopters tend to elicit a heightened response from nesting raptors (Watson 1993, Grubb and Bowerman 1997). Noise from low-level jets and sonic booms have been found to have little effect on nesting peregrine falcons and other raptor species (Ellis 1981, Ellis *et al.* 1991). UAVs are small and relatively quiet, and are expected to elicit less of a response than either helicopters or fixed-wing aircraft. Studies of the effects of aircraft overflights on nesting raptors often show slight, but non-significant decreases in reproductive success and number of young fledged (Platt 1977, Windsor 1977, Anderson *et al.* 1989, Ellis *et al.* 1991). Nest abandonment due to disturbance is most likely to occur early in the nesting season before birds have invested much energy in the nest and nestlings (Knight and Temple 1987). White and Sherrod (1973) found that nesting raptors flushed from nests when overflown by helicopters that approached unseen, suggesting that raptors may be more likely to flush if the noise or sight of the aircraft is sudden and in close range.

Studies of the effects of aircraft overflights on raptors have generally noted a slight but non-significant decrease in reproductive success and number of young fledged at sites exposed to overflights versus control sites without overflights (Delaney, *et al.* 1997). Of the authorized flights over spotted owl habitat, low-level helicopter flights have the greatest potential to disturb owls (Delaney *et al.* 1997), because they move slowly and are relatively noisy. Delaney *et al.* (1999) evaluated the effects of the Sikorsky, HH-60G, and Pave Hawk helicopter overflights on Mexican spotted owls in the Lincoln National Forest, New Mexico. Owl territories were randomly presented with one of three helicopter flight profiles, including 50 feet vertical, 100 feet vertical/100 feet lateral, and 200 feet vertical. Territories with overflights did not differ in reproductive success from territories without overflights. As the distance to the helicopter decreased, owl flush response increased. Owls did not flush in response to helicopters beyond 345 feet, and no owls flushed during the incubation and nestling phases. Flush responses occurred at a rate of 14 percent within 345 feet, 19 percent within 200 feet, and 50 percent within 100 feet. Flushing responses also did not occur when noise levels were less than 92 dBA; however, distance to the helicopter was a better predictor of spotted owl response than sound level. Net differences in prey deliveries for the 24 hour periods after and before noise manipulations were highly correlated with stimulus distance. Delaney *et al.* (1999) estimated that the threshold for negative effect on prey deliveries was 315 feet. On average, an alert response (i.e., head movements) was elicited when helicopters approached within 1,330 feet, but no response was noted when helicopters were beyond 2,165 feet from an owl. Short duration, single pass aircraft flights appeared to have little effects on spotted owls; diurnal flights affected owls less than nocturnal flights; and although multiple low-level flights were not recommended, the authors believed spotted owls would habituate with repeated exposures and as the nesting season progresses (Delaney *et al.* 1997, 1999). Although the effects of overflights may vary with locations, specific conditions, and aircraft type, the following management implications emerged from the results of Delaney *et al.* (1997, 1999):

1. A 345-foot hemispherical management/protective zone should minimize, and possibly eliminate, spotted owl flush response and negative effects to prey delivery rates associated with helicopter overflights.
2. Flights over owls should be separated by at least seven days.
3. Overflights should be limited to diurnal flights if possible, and nocturnal flights, particularly within three hours of sunrise or sunset, should be minimized.
4. Helicopter flights near roosts or nests that are single pass and of short duration may be less disturbing than other flight maneuvers such as circling, hovering, landing, etc.

Service policy is to limit disturbing activities within 1,320 feet of nest sites during the breeding season (March 1-August 31). This corresponds well with the Delaney *et al.*'s 1,330-foot threshold for alert responses to helicopter flights. Encounters between low-level flights and spotted owls are expected to be infrequent. Russell Duncan (pers. comm. 1998) during extensive wildlife and plant surveys, has never observed a low-level helicopter or fixed-wing aircraft flight in the Huachuca Mountains. Low-level UAV flights are more common, but UAVs are small and relatively quiet compared to helicopters, and are expected to elicit minimal response from spotted owls. The Fort has committed to minimizing low-level helicopter flights within 1.0 mile of spotted owl nests, or the last previously known nest. Helicopter flights closer than 0.25 mile of active nests will be prohibited from March 1 to August 31 (Appendix 1). These commitments should minimize adverse effects, including the potential for take, associated with low-level aircraft flights.

Stacey and Hodgson (1995) evaluated the impacts of a 24,000 acre natural fire on Mexican spotted owls in the San Mateo Mountains, New Mexico. Birds present in four territories before the fire remained within their same territories after the fire. However, a small sample size of owls combined with an apparent low-intensity fire (the fire burned patchily, only 600 acres burned hot enough to kill all trees, and much undamaged roosting and foraging habitat remained) makes the applicability of the study results to other owl territories or other fires questionable. Relatively few wildfires have burned in the montane portion of the Fort in recent times (Figure 7); however, fuel loads are high in some areas (Robinett *et al.* 1997), and several stand-replacing fires have occurred in the Huachuca Mountains to the south of the Fort in recent years. Thus, a very hot, stand-replacing fire could potentially burn in owl territories on Fort Huachuca, perhaps with much more severe impacts than those observed by Stacy and Hodgson (1995) in New Mexico.

Prescribed fire, managed natural fire, or wildfire ignited by recreationists or by ordnance strikes in the Huachuca Mountains, could result in adverse effects to owls and their habitat. Direct effects to Mexican spotted owl may include death of adults and/or juveniles, flushing of Mexican spotted owl off nests/roosts, smoke inhalation, and human disturbance related to fire suppression actions. Indirect effects may include loss or degradation of nesting or foraging habitat, and reduced prey densities and availability.

Patton *et al.* (1991) found lower survival rates among radio-tagged female northern spotted owls following a forest fire. This was attributed to radio tags, but the birds in this study were exposed to dense smoke and high levels of carbon monoxide by an inversion that trapped smoke near the ground for 25 days following a fire which burned for 50 days. Flames and smoke from fire may cause Mexican spotted owls to flush from nests and/or roosts, and may impair hunting opportunities through interfering with audio and visual methods of detecting prey. If fire occurs within PAC activity centers, there exists some possibility that nest and/or roosts trees may be killed through crowning or extreme heat. All of these may result in direct mortality, failed reproductive efforts and/or starvation of young and adult Mexican spotted owl.

Disturbance to the Mexican spotted owl may also be caused by human activities in, adjacent, and above PACs and potentially occupied habitat during fire suppression or management activities. Disturbance may be caused by fire resource personnel digging fire lines with shovels and other hand tools, walking and igniting with drip torches if "burning out" is needed to control a fire, use of chainsaws and heavy equipment, the dropping of slurry, and monitoring fire conditions from the ground or air. Human disturbance in an occupied PAC during the breeding season may result in failed reproductive efforts, abandonment of the nest, and/or starvation of young.

The indirect effects of fire include both negative and beneficial effects on Mexican spotted owl habitat. Beneficial aspects would include increased response of herbaceous vegetation after a fire and possible reduced future occurrence of stand-replacing fire. Negative effects would include the loss of Mexican spotted owl prey habitat components such as herbaceous cover, down logs and snags. The effects of fire on the prey base of the Mexican spotted owl are complex and are dependent on the variations in fire characteristics and in prey habitat. Fire intensity, size, and behavior are influenced by numerous factors such as vegetation type, moisture, fuel loads, weather, season, and topography. Fire can effectively alter vegetation structure and composition thereby affecting small mammal habitat. The initial effects of fire are likely to be detrimental to rodent populations as cover and plant forage species would be reduced.

Population responses by small mammals to fire-induced changes in their habitat vary. For example, deer mouse populations might increase immediately following fire and then decrease through time (Ward and Block 1995). Campbell *et al.* (1977) noted that populations of peromyscid mice decreased immediately following fire in an Arizona ponderosa pine forest that removed one-fourth (moderately burned) to two-thirds (severely burned) of the basal area; populations then returned to pre-fire numbers two years following the burn. Furthermore, no differences were found in rodent populations between moderately and severely burned areas. They concluded that the effects of the fire that they studied were short-term, and the short-term positive numerical responses of mice were attributed to an increase in forage, particularly grasses and forbs after the fire (Ward and Block 1995). Irvine (1991) documented post-fire declines in deer mice populations at study sites on the Coconino National Forest. Irvine attributed these declines to reduced food supplies. Lowe *et al.* (1978) noted an increase in deer mice populations the first year after a fire in ponderosa pine near Flagstaff, Arizona. Small mammal diversity and densities are typically depressed for one to three years after a fire (Wright and Bailey 1982). Biswell *et al.* (1973) suggested that rodent populations would be less affected during fall fires, because at that time of year rodents have accumulated seed caches that will mitigate loss of food sources. Predation of surviving rodents that are part of the diet of the Mexican spotted owl may increase immediately after the fire. In one study in northern California, radio-collared northern spotted owls spent considerable time in burned-over areas. This activity was assumed to be due to easy capture of prey (Patton and Gordon 1995).

It is suspected that the effects of intense stand-replacing wildfires that dramatically alter forest structure and move the system to earlier seral stages would have longer-term effects on some rodent populations. Likely, early successional species such as deer mice and those that require open habitat with a well-developed herbaceous understory, such as microtine voles and pocket gophers, would benefit. In contrast, species that require a wooded or forested overstory would exhibit population declines. The net effect of such fires on the Mexican spotted owl is unclear. A fire that removes the tree canopy would likely render a portion of the area unusable for foraging by Mexican spotted owl, but if the spatial extent of crown loss is limited, a mosaic is created that could provide a diversity of prey for the owl and actually be beneficial (Ward and Block 1995). Because owl prey species evolved in ecosystems where fire was a natural process, we assume that historically, these species survived, and some even benefited from the occurrence of fire. Fire has been excluded from most southwestern ecosystems during the 20th century, resulting in systems where fire behavior may deviate substantially from natural conditions. Effects of fire on small mammals under present environmental conditions are unclear (Ward and Block 1995).

Fire is likely to have immediate short-term adverse effects to Mexican spotted owl prey habitat. Although fire may enhance vegetative density and abundance in the long-term, short-term effects of burning, particularly in the spring and early summer when herbaceous vegetation is most critical for reproducing rodents, may limit available forage immediately

after the fire event. Wildfire would most likely occur in June before the onset of the monsoon. Nesting Mexican spotted owls would be most affected during this time, as they would be nesting and require a consistent supply of prey to successfully fledge young.

Prescribed and managed natural fire are extremely important management tools needed to enhance, and often to restore many of the ecosystem functions and processes. Reduction in habitat and various habitat-based threats have contributed to the listing of the Mexican spotted owl. The long-term benefits to the Mexican spotted owl of many land management actions may contribute, in the short-term, to certain adverse effects to the owl. Prescribed and natural fire projects often fall into this category. Species such as the owl, whose habitats have been reduced, degraded, or altered, may currently respond to fire differently than they did historically when fire occurred in a more natural setting. Therefore, it is important to address such concerns by minimizing, to the greatest extent practical, those short-term adverse effects, and move forward with proactive land management as fire is applied in efforts to restore ecosystem functions and community dynamics.

Fires have played an important role in the composition and structure of conifer forests. Generally, historic natural fires in ponderosa pine were light, its intensity depending of fuel loadings and weather conditions. This created a situation whereby some areas did not burn, some areas burned intensely with crown fires, and most areas burned lightly leaving large fire resistant trees, killing shrub topgrowth, and removing dead fuels (Wright and Bailey 1982). In mixed conifer forests, historic fires often were composed of intense, crown-replacement in small patches. Prescribed fire may be expected to alter mixed conifer habitats of the Mexican spotted owl in the short-term to a greater extent now than historically because the fuel accumulations that are characteristic of many Mexican spotted owl nest and roost sites generally place them at higher fire risk.

Prescribed or managed natural fire are likely to create small openings in the canopy caused by single or groups of trees crowning. The Service believes the risk of trees crowning is more probable in Mexican spotted owl nesting/roosting habitat. The location of quality owl habitat often corresponds to characteristics that put these sites at higher risk of crowning such as dense, multi-layered canopies, and high fuel loadings resulting from high densities of down logs. Where fire does not crown, some loss of the lower canopy is expected. This is likely to be particularly true in mixed conifer habitats which are usually denser and contain more of the "ladder fuels" created by smaller conifer trees. The loss of some of the lower branches in the canopy may have some effect on Mexican spotted owl foraging. Mexican spotted owl utilize the "perch and pounce" method of hunting, using the lower branches of trees for perching. The loss of some perching sites when burning within prescription is not expected to significantly affect the ability of Mexican spotted owl to forage successfully.

The Recovery Plan encourages fire management programs that take an active role in fuels management and understand the ecological role of fire. The Recovery Plan also recognizes that catastrophic wildfire is one of the primary threats to the owl. Therefore, fire plays the dual role of being both potentially beneficial and catastrophic to the owl and its habitat. The Service stresses the need to apply adaptive management when using fire. Prescriptions that maintain key structural features of owl and small prey habitats should be developed and tested. These features include large trees, snags, logs, and overstory. Treatments to produce or maintain such habitat components must be assessed by monitoring to evaluate if treatment objectives were met in both the short and long term. Wholesale use of fire without understanding or monitoring its effects on habitat may render these areas unusable by owls, and may also miss opportunities to improve our knowledge of fire effects on these habitats (Moir *et al.* 1995). In regard to managed natural fire in the Kachina Burn Plan, the Coconino National Forest committed to protecting 80-90 percent of the downed logs 12 inches diameter at breast height (dbh) and greater, and to hand-lining snags 18 inches dbh and greater for all managed natural fire actions within Mexican spotted owl protected and restricted habitat as defined by the Mexican Spotted Owl Recovery Plan (Service 1995). These protective measures will assist in maintaining these important components of Mexican spotted owl prey habitat. The Service believes these measures will assist in ensuring that these habitat components of importance to the Mexican spotted owl are retained in the PACs.

The Recovery Plan recognizes that managed natural fire may be beneficial to owl habitat in several ways: 1) it can aid in reducing fuel loads and the risk of catastrophic wildfire which may result in the loss of habitat over large areas; 2) it can create a diverse landscape with considerable horizontal heterogeneity which seems to be relatively characteristic of many areas occupied by spotted owls and also provides for a diverse prey base; 3) it can create conditions that maintain shade-intolerant species in the landscape.

Prescribed fire should be used carefully in owl habitat (Service 1995). Fire is one of the most rapidly acting of natural disturbances. A crown fire can quickly consume vast tracts of forested habitat. After a large crown fire, habitat components for Mexican spotted owl nesting, roosting, and foraging are reduced or eliminated. Small-scale natural fires and prescribed burns, however, can reduce fuel loadings and create small openings and thinned stands that increase horizontal diversity and reduce the spread of catastrophic fire. Small-scale fires and lightning strikes also create snags, canopy gaps, and large downed logs, plus they perpetuate understory shrubs, grasses, and forbs which are important habitat components to the owl and its prey (Moir *et al.* 1995).

The Recovery Plan states that the nest site should be known before burning occurs in the PAC, as this information is needed to determine the location of the 100-acre activity center and protect it from fire. The Service believes that the most accurate, up-to-date information needs

to be used to determine 100-acre activity centers before prescribed or managed natural fire is allowed to burn in PACs. Service policy is to consider PACs occupied each breeding season.

The following summarizes recommendations from the Mexican Spotted Owl Recovery Plan in regard to prescribed fire in PACs:

1. Experimentally treat (prescribed fire and fuels management) ten percent of PACs within each recovery unit that exhibit high fire risk conditions (use of prescribed fire without mechanical treatments is not limited, except within the 100-acre nest site: #4).
2. Treatments should retain or enhance owl habitat components
3. Treatments should only occur during the non-breeding season (September 1 to February 28).
4. A 100-acre area around the known nest site is to be excluded from treatments.
5. Effects of treatments on the owl, prey species, and their habitats should be assessed.

If such effects are not negative, an additional sample of PACs can be treated. If negative effects are detected, measures should be developed to ameliorate those effects. If effects cannot be mitigated, no additional treatments should be permitted.

The Recovery Plan finds that catastrophic wildfire is a primary threat to the Mexican spotted owl. The Service believes that in some areas of the Huachuca Mountains prescribed fire or fuels treatment is necessary to avoid occurrence of a stand-replacing fire that would be highly deleterious to spotted owl habitat. Where the risk of stand-replacing fire is high in the Huachuca Mountains, the benefits of treatments to reduce that risk are likely to outweigh possible direct adverse effects of such treatments on the owl or its habitat.

The Fort has adopted the recommendations of the Recovery Plan in regard to prescribed fire, managed natural fire, and fuel treatments, with some modifications as suggested by the Service (Appendix 1). Commitments include not burning within the 100-acre core areas, not removing trees larger than 9 inches dbh in PACs, enhancement or retainment of owl habitat components during treatments, limiting prescribed or managed natural fire treatments within PACs to 100 acres at a time and only outside of the breeding season, and other measures as described in Appendix 1. Although fire is an imprecise tool, these measures greatly reduce the likelihood that treatments will damage spotted owl habitat or result in take. Properly applied, a fire program should provide long term protection of owl habitat from catastrophic wildfire.

Cumulative Effects

Cumulative effects are those adverse effects of future non-Federal (State, local government, and private) actions that are reasonably certain to occur in the project area. Future Federal actions would be subject to the consultation requirements established in section 7 of the Act and, therefore, are not considered cumulative to the proposed action. Effects of past Federal and private actions are considered in the Environmental Baseline. Because of the extent of Federal lands in the area (Coronado National Forest, Fort Huachuca, Coronado National Memorial, and BLM), many activities will involve Federal agencies, and thus are not considered cumulative effects. In particular, potential nesting habitat of the Mexican spotted owl in the project area is in the montane canyons of the Huachuca Mountains. These canyons are, for the most part, managed by Federal agencies. Exceptions include the Peterson Ranch in Scotia Canyon, lower Ramsey Canyon, and other small parcels, mostly in the lower reaches of the canyons. Most of these sites are too low in elevation to support nesting spotted owls, although the species may use these areas when not nesting. Owls have been recorded nesting near the Peterson Ranch property, but it will likely be acquired by the Coronado National Forest through a land exchange.

Population growth in the Sierra Vista area and the popularity of the area as a recreational destination is resulting in increased use of Mexican spotted owl habitat in the Huachuca Mountains. In addition, private lands at the mouths of many canyons to the south of Fort Huachuca are being developed as housing tracts or ranchettes. The lower reaches of these canyons may provide wintering spotted owl habitat. This increasing human presence is likely to result in increased disturbance of any Mexican spotted owls in the area.

Effectiveness of Proposed Mitigation

The Fort has proposed many important mitigation measures as part of the proposed action that would reduce or eliminate most potential adverse effects to the species and its habitat resulting from the proposed action (see "Proposed Mitigation Measures" and Appendix B of the MOA - in Appendix 1 herein). Mitigation in Appendix B consists primarily of measures that were recommended by the Service to the Fort to reduce the likelihood of take. These measures were adopted by the Fort as part of the proposed action. Mitigation measures that are expected to benefit the Mexican spotted owl can be summarized as follows: (1) designating a point of contact at Fort Huachuca who will have the responsibility of ensuring that activities comply with terms and conditions, and mitigation; (2) annual surveys for Mexican spotted owl; (3) environmental awareness training; (4) wildfire suppression and prevention measures; prescribed fire and fuels management to reduce fuel loads and the chance of catastrophic fire in the canyons of the Huachuca Mountains; (5) measures to reduce the impact of managed fire and fire suppression, (6) agreements with local governments and the Coronado National Forest that provide for the assistance of these entities in fire suppression; (7) minimal military training

in the Huachuca Mountains; (8) prohibition of recreational rock climbing and rappelling; and prohibiting training-related rappelling within 0.25 mile of an active nest, (9) limiting aircraft flights below 500 feet AGL and helicopter flights near PACs and nest sites; (10) preparation of a species-specific management plan for the Mexican spotted owl, and (11) limitations on recreational activities in Scheelite Canyon.

CONCLUSION

After reviewing the current status of the Mexican spotted owl, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Mexican spotted owl. No critical habitat is designated for this species, thus none will be affected. Our conclusion of "no jeopardy" is based on the following:

1. Mexican spotted owls at Fort Huachuca occur primarily in remote canyons of the Huachuca Mountains that few recreationists visit (an exception being Scheelite Canyon) and where little or no military training occurs.
2. Few military overflights occur in the canyons of the Huachuca Mountains where spotted owls occur, and most flights occur above 500 feet AGL.
3. Recreational rock climbing and rappelling is prohibited at Fort Huachuca. Rappelling as part of military training is restricted to a cliff in Garden Canyon, which is outside of current owl PACs.
4. The threat of wildfire is being addressed by the Fort through a comprehensive fire management plan that calls for prescribed fire and reduction of fuel loads. Implementation of the plan will help reduce the chance of catastrophic stand-replacing fire that could adversely affect owl nesting and foraging habitat.
5. The proposed action affects a relatively small portion of the range of this threatened species.
6. The Fort proposes substantial mitigation measures that reduce the effects of the action on the Mexican spotted owl.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Harass is defined in the same regulation by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take of a listed animal species that is incidental to, and not the purpose of, the carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of sections 7(b)(4) and 7(o)(2) of the Act, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by Fort Huachuca so that they become binding conditions of any grant or permit issued to any applicant, permittee, or contractor, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Fort has a continuing duty to regulate the activity covered by this incidental take statement. If the Fort (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant, permittee, or contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Fort Huachuca must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

Take may be in the form of harm, harassment, injury, or death resulting from the loss of a nesting site, loss or disturbance of a nest by recreational or military activities, loss or degradation of foraging habitat as a result of fire, and collision of a Mexican spotted owl with a vehicle, antennae, fences or other project features. The Service anticipates incidental take of Mexican spotted owl will be difficult to detect or determine. The Fort's proposed mitigation measures greatly reduce the chance that take would occur; however, we anticipate the take, through direct injury or mortality, or harm of a total of two Mexican spotted owls, or one nest with eggs/nestlings as a result of the above causes over the life of the project at Fort Huachuca.

Additionally, take of one Mexican spotted owl is anticipated in the Scheelite Canyon PAC and one Mexican spotted owl elsewhere at Fort Huachuca over the life of the project as a result of harassment due primarily to recreational activities, but also possibly as a result of other causes listed above.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. This biological opinion does not authorize any form of take not incidental to implementation of the proposed action as described in this opinion and in SAIC (1998a). Although take is anticipated as a result of unauthorized recreational activities, such take is not authorized under this incidental take statement.

EFFECT OF THE TAKE

The Service has determined that the level of anticipated take is not likely to jeopardize the continued existence of the Mexican spotted owl.

The Service will not refer the incidental take of Mexican spotted owl for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§703-712), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measure is necessary and appropriate to minimize impacts of incidental take of the Mexican spotted owl:

Prompt implementation of proposed mitigation measures.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Fort must comply with the following term and condition in regard to the proposed action. This term and condition implements the reasonable and prudent measure described above. Terms and conditions are nondiscretionary. Note that the Fort must ensure that contractors, permittees, and others that may implement part of the proposed action comply with these terms and conditions. This

includes other agencies/entities, such as the Coronado National Forest, that assist the Fort with fire suppression or management.

The following term and condition implements the reasonable and prudent measure:

The Fort shall promptly implement measures 3, 4, 6, 7, 8, 10, 11, 12, 13, 15, 16, and 17 of the "Proposed Mitigation Measures" in the "Description of the Proposed Action", and mitigation measures specific to the Mexican spotted owl, as well as the general mitigation measures and reporting requirements, in Appendix B of the MOA (Appendix 1 herein).

If the incidental take anticipated in the paragraph entitled "Amount or Extent of Take" is met, the Fort shall immediately notify the Service in writing. If, during the course of the action, the level of anticipated incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation. In the interim, the Fort must cease the activity resulting in the take if it is determined that the impact of additional taking will cause an irreversible and adverse impact on the species. Fort Huachuca must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information on listed species. The recommendation provided here does not necessarily represent complete fulfillment of the agency's section 2(c) or 7(a)(1) responsibilities for the Mexican spotted owl. In furtherance of the purposes of the Act, we recommend implementing the following action:

The Fort should study the effects of recreational activity on Mexican spotted owls and their habitat in Scheelite Canyon. The study should quantify recreational use, effects on owl behavior, energetics, movements, and reproduction, as well as effects to the habitat resulting from trampling, potential for fire, etc.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitat, the Service requests notification of the implementation of any conservation recommendations.

Lesser Long-nosed Bat

STATUS OF THE SPECIES

The lesser long-nosed bat was listed (originally, as *Leptonycteris sanborni*; Sanborn's long-nosed bat) as endangered on September 30, 1988 (53 FR 38456). No critical habitat has been designated for this species. The lesser long-nosed bat is a small, leaf-nosed bat. It has a long muzzle and a long tongue, and is capable of hover flight. These features are adaptations to feed on nectar from the flowers of columnar cactus, such as the saguaro and organ pipe cactus and from paniculate agaves, such as Palmer's agave, *Agave palmeri*, and Parry's agave, *A. parryi* (Hoffmeister 1986). Palmer's agave exhibit many characteristics of chiropterophily, such as nocturnal pollen dehiscence and nectar production, light colored and erect flowers, strong floral order, and high levels of pollen protein with relatively low levels of nectar sugar concentrations (Slauson 1996). Parry's agave demonstrates many (though not all) of these same morphological features (Gentry 1982).

The lesser long-nosed bat is migratory and found throughout its historic range, from southern Arizona and extreme southwestern New Mexico, through western Mexico, and south to El Salvador. It has been recorded in southern Arizona from the Picacho Mountains (Pinal County) southwest to the Agua Dulce Mountains (Pima County), southeast to the Chiricahua Mountains (Cochise County), and south to the international boundary. Roosts in Arizona are typically occupied from as early as late April to as late as October 20 (Cockrum and Petryszyn 1991, Sidner 1999); the bat has only rarely been recorded outside of this time period in Arizona (Fleming 1995, Hoffmeister 1986). In spring, adult females, most of which are pregnant, arrive in Arizona gathering into maternity colonies. These roosts are typically at low elevations near concentrations of flowering columnar cacti. After the young are weaned these colonies disband in July and August; some females and young move to higher elevations, primarily in the southeastern parts of Arizona near concentrations of blooming paniculate agaves. Adult males typically occupy separate roosts forming bachelor colonies. Males are known mostly from the Chiricahua Mountains but also occur with adult females and young of the year at maternity sites (Fleming 1995). Throughout the night between foraging bouts both sexes will rest in temporary night roosts (Hoffmeister 1986).

As indicated above, the lesser long-nosed bat consumes nectar and pollen of paniculate agave flowers and the nectar, pollen, and fruit produced by a variety of columnar cacti. These bats often forage in flocks. Nectar of these cacti and agaves are high energy foods. Concentrations of some food resources appear to be patchily distributed on the landscape and the nectar of each plant species utilized is only seasonally available. Cacti flowers and fruit are available during the spring and early summer; blooming agaves are available primarily from July through October. Columnar cacti occur in lower elevation areas of the Sonoran Desert region, and paniculate agaves are found primarily in higher elevation desert scrub areas, desert grasslands and shrublands, and into the oak woodland (Gentry 1982). In the Huachuca

Mountains, Parry's agave is generally found at higher elevations than Palmer's agave; the former is common in forest openings to the crest of the Huachuca Mountains.

Lesser long-nosed bats appear to be opportunistic foragers and efficient fliers. Seasonally available food resources may account for the seasonal movement patterns of the bat. The lesser long-nosed bat is known to fly long distances from roost sites to foraging sites. Night flights from maternity colonies to flowering columnar cacti have been documented in Arizona at 15 miles, and in Mexico at 25 miles and 38 miles (one way)(Dalton *et al.* 1994, Yar Petryszyn, University of Arizona, Tucson, pers. comm. 1997). Fleming (1995) suggests that a substantial portion of the lesser long-nosed bats at the Pinacate Cave in Sonora fly 25 to 31 miles each night to foraging areas in Organ Pipe Cactus National Monument. Horner *et al.* (1990) found that lesser long-nosed bats commuted 15.5 miles between an island maternity roost and the mainland in Sonora. The authors suggested that bats regularly flew at least 47 miles each night. Lesser long-nosed bats have been recorded visiting individual blooming Palmer's agaves in excess of 1,000 visits per night (Ronnie Sidner, Tucson, Arizona, pers.comm. 1997), while other agaves may not be visited at all (Liz Slauson, Desert Botanical Gardens, Phoenix, Arizona, pers. comm. 1997). Lesser long-nosed bats have been observed feeding at hummingbird feeders many miles from the closest known potential roost site (Yar Petryszyn, pers. comm. 1997).

Loss of roost and foraging habitat, as well as direct taking of individual bats during animal control programs, particularly in Mexico, have contributed to the current endangered status of the species. Suitable day roosts and suitable concentrations of food plants are the two resources that are crucial for the lesser long-nosed bat (Fleming 1995). Caves and mines are used as day roosts. The factors that make roost sites useable have not yet been identified. Whatever the factors are that determine selection of roost locations, the species appears to be sensitive to human disturbance. Instances are known where a single brief visit to an occupied roost is sufficient to cause a high proportion of lesser long-nosed bats to temporarily abandon their day roost and move to another. Perhaps most disturbed bats return to their preferred roost in a few days. However, this sensitivity suggests that the presence of alternate roost sites may be critical when disturbance occurs. Interspecific interactions with other bat species may also influence lesser long-nosed bat roost requirements.

Known major roost sites include 16 large roosts in Arizona and Mexico (Fleming 1995). According to surveys conducted in 1992 and 1993, the number of bats estimated to occupy these sites was greater than 200,000. Twelve major maternity roost sites are known from Arizona and Mexico. According to the same surveys, the maternity roosts are occupied by over 150,000 lesser long-nosed bats. The numbers above indicate that although a relatively large number of these bats are known to exist, the relative number of known large roosts is small. Disturbance of these roosts and the food plants associated with them could lead to the

loss of the roosts. Limited numbers of maternity roosts may be the critical factor in the survival of this species.

ENVIRONMENTAL BASELINE

Records of the lesser long-nosed bat at Fort Huachuca and areas within foraging distance of Fort Huachuca (~40 miles) include: 1) Panama Mine near Pyeatt Ranch on the western boundary of Fort Huachuca, 2) Pyeatt Cave, Fort Huachuca, 3) Manila Mine, Fort Huachuca, 4) Woodcutters Canyon, Fort Huachuca, 5) Wren Bridge, Fort Huachuca, 6) Brown Canyon, Huachuca Mountains, 7) Canelo Mine eight miles west of Fort Huachuca, 8) Miller Canyon, Huachuca Mountains, 9) San Pedro RNCA at Fairbank, 10) Ramsey Canyon, Huachuca Mountains, 11) State of Texas Mine, Coronado National Memorial, Huachuca Mountains, 12) Cave of the Bells, Santa Rita Mountains, 13) Helvetia, Santa Rita Mountains, 14) Madera Canyon, Santa Rita Mountains, 15) Empire Ranch north of Sonoita, 16) several localities near Patagonia, and 17) Colossal Cave, Pima County (Cockrum and Petryszyn 1991, Fleming 1995, Sidner 1993, 1994). Of the above sites, Fleming (1995) considered the Patagonia Bat Cave, Manila Mine, State of Texas Mine, and the Cave of Bells to be major post-maternity roosts of the lesser long-nosed bat. Three major maternity roosts and five major post-maternity roosts are known in Arizona. Post-maternity roosts are typically transitory roosts used by adults and/or young bats in summer or fall (Fleming 1995). Of the sites at Fort Huachuca, lesser long-nosed bats have been found day roosting at Pyeatt Cave and Manila Mine (some night roosting occurs at these sites as well). Wren Bridge is a night roost, and lesser long-nosed bats were mist-netted in Woodcutters Canyon (Sidner 1996, 1994, 1999). Upper Pyeatt Cave and Indecision Cave are considered potential day roosts, but the species has yet to be documented at these sites (Sidner 1996, 1999). A lesser long-nosed bat banded at Wren Bridge was found the next night at the Patagonia Bat Cave, demonstrating that individuals of this species move relatively long distances and bats at Fort Huachuca are part of a larger regional population (Sidner 1996, Howell 1996).

Annual peak numbers of lesser long-nosed bats observed roosting at Manila Mine have varied from 1,439 in 1993 (Sidner 1994) to 24 in 1990 (Sidner 1992). At Pyeatt Cave numbers have varied from one to over 500 roosting lesser long-nosed bats (Sidner 1999). At Wren Bridge small numbers of lesser long-nosed bats have been observed night-roosting under the bridge. Roosting lesser long-nosed bats have been recorded at Fort Huachuca from late July into October. Numbers of bats typically peak in early September (Sidner 1996). Howell (1996) suggests that there are many potential roost sites in the Huachuca Mountains where hundreds of nectar feeding bats could roost without being detected.

Sensitivity of roosting lesser long-nosed bats to human disturbance lead the Fort to close Manila Mine, Pyeatt Cave, and Upper Pyeatt Cave to entry from April 15 through October 31

of each year. Entrances to these caves/mine are fenced with chain link in a way that inhibits illegal human entry but does not interfere with bats entering or exiting the roosts. The caves/mine are also posted, although the signs are in disrepair. The access roads to Manila Mine and Pyeatt Cave are gated and locked. The access route to Upper Pyeatt Cave is open to the public, but it is a rough, four-wheel drive trail that receives little use. Each of these three sites are equipped with electronic sensors that detect human intruders. The sensors alert Wildlife Management personnel that an illegal entry has occurred. Monitoring of these sites in 1990, shortly after seasonal closures were enforced, revealed evidence of numerous illegal entries. The situation has improved, and increasing numbers of lesser long-nosed bats in the early 1990s may have been due in part to controlling human use (Sidner 1992).

Lesser long-nosed bats require suitable forage plants. At and near Fort Huachuca, forage plants include Palmer's agave and possibly Parry's agave (the two are known to hybridize, as well.) The former species is most important for the lesser long-nosed bat at the lower elevations of the training ranges. It is in these areas where training and fire caused by ordnance and small arms discharge are most likely to affect agave populations. Agaves in desert grasslands have evolved with fire, but unnatural, high fire frequency can lead to decline or elimination of agave populations (Howell 1996). Howell (1996) suggests that the natural fire frequency for agave areas on the South Range is probably 10-15 years, with a range of 8-22 years. Fire frequencies throughout the Fort are shown in Figure 7, and as can be seen, many areas of the West and South ranges have fire frequencies in excess of this.

Sensitive to the need to protect agave stands, the Fort established Agave Management Areas (Figure 8) to protect the largest populations of Palmer's agave. The following range use restrictions apply to Agave Management Areas:

These training areas, as well as the rest of the South and West Ranges, will be off-limits to all off-road vehicle travel including armor and tracked vehicles.

Pyrotechnics will be banned from use within these areas.

Fires in these areas will be actively suppressed unless the area is approaching its natural fire return interval of 10 years, in which case a prescribed burn may take place.

Training and test sites in these areas will not be used by personnel on foot unless the activity has a range control-approved plan for fire suppression and appropriate fire fighting equipment.

These restrictions flow from the "Agave Management Plan" (Howell and Robinett 1996) that included the following management recommendations:

1. Establishment of Agave Management Areas

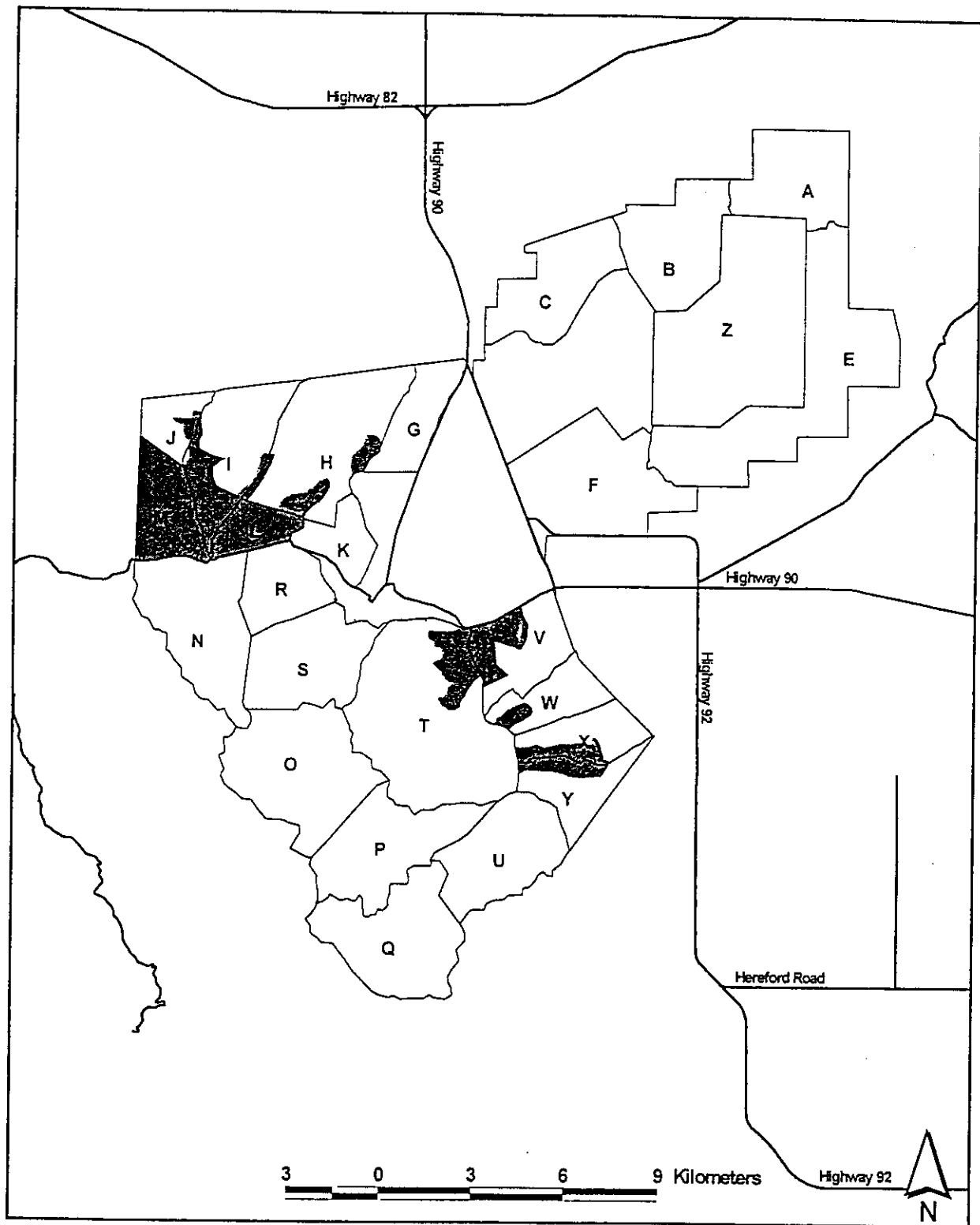


Figure 8: Agave management areas

 Agave Stands
 Major Roads
 Fort Huachuca Training Areas

SOURCE: ENRD, 1996

2. The following management prescriptions would be applied in the Agave Management Areas:

- A. No off-road vehicle activity, including armor and tracked vehicles.
- B. No pyrotechnics
- C. No tank training in these areas on the West Range
- D. Fire will be actively suppressed unless the area is approaching its natural fire return interval of 10 years.
- E. Training and test sites in these areas will not be used by personnel on foot unless the activity has a range control-approved plan for fire suppression and minimal fire fighting equipment.

Howell and Robinett (1996) further recommended that additional signs informing range users that vehicles must stay on roads and that pyrotechnics are prohibited need to be placed in certain areas, and that military trainers and civilian testers who fail to comply with the measures should be subject to losing their privilege to train at Fort Huachuca. Also recommended was designation of an Agave Protection Coordinator. This coordinator would: 1) serve as a contact point for range users, 2) maintain a data base of reports, regulations, monitoring results, and other printed materials relevant to agaves, 3) develop and distribute to range users an agave information packet that would include a map of agave management areas, the Department of Game Management Environmental Information Fact Sheet, a 1990 video, a brief statement about agaves, and a summary of research activities; 4) visit project sites within agave management areas and prepare a brief statement on effects to agaves; 5) act as a clearing house for research and contract reports on agaves; 6) supervise and provide quality control on surveys and agave research; 7) maintain the Fire Management Plan Burn Map; 8) act as a liaison between the Fort and the Service in regard to agave management; and 9) provide oversight of mitigation.

Other recommendations in Howell and Robinett (1996) include several measures to make fire protection more effective, protection of the densest stand of agaves in agave management areas if prescribed fire is applied in these areas, only applying prescribed fire from November through March, rotation grazing by horses in a manner that plant communities can recover between uses, fencing of dense stands of agaves in Areas K and H if grazing impacts the trend of these agave communities, discouragement of foot troops above the platoon size, briefings and environmental awareness materials would be provided to foot troops or civilians on foot that use agave management areas, research and monitoring recommendations, and suggested means for interagency coordination of agave management activities. Implementation of the agave management plan is as yet incomplete. Tom Cochran, Fort Huachuca, (pers. comm. 1998) reports that restrictions (items a-e above) are being followed, but many of the other recommendations, such as appointment of an agave coordinator, environmental awareness

training and briefings, and monitoring and inventory recommendations, have not yet been implemented completely.

The Fort employs prescribed fire on the training ranges in areas of high fire danger to reduce fuel loads and thereby reduce chances that fire will spread to Agave Management Areas or other sensitive areas of Fort Huachuca. Existing roads and a series of maintained fire breaks on the bajada and on the lower slopes of the Huachuca Mountains also act to reduce the chance that fire will spread very far (Robinett *et al.* 1997).

Prior to the current consultation, the only formal section 7 consultation at Fort Huachuca evaluated the effects of prescribed fire proposed on the South Range in areas downrange of firing ranges 6, 8, 9, 10, and 12 in Tango-2 and Tango-3 during spring of 1991 (2-21-91-F-083, Table 1). The proposed action also included construction and enhancement of fire breaks around agave stands, initiation of a 10-year study on the effects of fire on agaves, and an annual stalk density survey. The lesser long-nosed bat was the only listed species evaluated in the biological opinion, which found that the proposed action would not jeopardize the continued existence of that species. Recently, the Fort informally consulted on elements of a prescribed fire plan for the vicinity of Alpha Break and firing ranges 6 through 10 on the South Range. The primary purpose of the project was to reduce the chance that ignitions started by small arms fire on the South Range might spread to the wooded slopes of the Huachuca Mountains. The Service concurred with the Fort's determination that the action may affect, but is not likely to adversely affect the lesser long-nosed bat (2-21-98-I-310, Table 1).

EFFECTS OF THE PROPOSED ACTION

The lesser long-nosed bat is most sensitive to activities that might adversely affect roost sites, particularly recreational caving. Other elements of the proposed action may affect foraging habitat or foraging bats, including fire ignited by ordnance, recreationists or other human activities; prescribed or managed natural fire; noise from aircraft or weapons firing; collisions of bats with vehicles, powerlines, and other project features; grazing by horses; construction activities that might result in mortality of forage plants; and individual agaves that may be damaged directly by ordnance or by bivouacs or other training activities.

As discussed in the Environmental Baseline, roosting lesser long-nosed bats are very sensitive to human intrusion. Recreational cavers entering Manila Mine, Pyeatt Cave, or other sites where lesser long-nosed bats might day roost could result in temporary or permanent desertion of the roost. However, Manila Mine and Pyeatt Cave (where lesser long-nosed bats have been confirmed), as well as upper Pyeatt Cave (potential habitat) are closed seasonally from April-October when bats may be present. The Fort protects the entrances of these roosts with chain link fence (but the bats can still get through), the entrances are posted, the access roads to

Manila Mine and Pyeatt Cave are gated and locked seasonally, the road to Upper Pyeatt Cave is rough and little used, and motion sensors alert the Fort of illegal entry. Thus, the Fort has taken many precautions to ensure that the bats are not disturbed. Jim Hessel (pers. comm. 1998) reports that the signs at the entrances are in disrepair and the motion sensors need some work; nonetheless, disturbance by cavers of known roosts sites appears to be minimal.

Of the various components of the proposed action, prescribed or managed fire and wildfire suppression have the greatest potential to adversely affect agaves, and forage plant availability. Whether forage resources are limiting to lesser long-nosed bat populations in the Huachuca Mountains is unknown. Liz Slauson, working at several sites in southeastern Arizona, has never observed agave flowers drained of nectar, suggesting nectar availability is not limiting. However, the bats fly south in September or October at a time when blooming agaves are becoming less and less abundant, suggesting a waning food supply may be one of the factors that triggers migration. Yar Petryszyn (pers. comm. 1999) has observed apparent agonistic behavior of bats at agave flowers late in the season, suggesting possible competition for resources. If forage resources are limiting at times or certain places, we would expect that in some years or some areas, numbers of bats may be reduced, or bats may have to fly farther from their roosts to obtain sufficient resources, as a result of insufficient blooming agaves. Bats that fly greater distances are probably more vulnerable to predation or accidental death. Under a scenario of limiting food resources, damage or death of agaves due to prescribed fire could conceivably further reduce forage resources and bat numbers. Although the question of whether agaves are limiting to lesser long-nosed bats in the project area is unanswered, it seems likely that landscape-scale projects, such as a prescribed fire, that are adjacent to important roosts will probably have some effects on bat foraging behavior, and some of these are likely to be adverse effects. The Service considers loss of forage resources a great enough threat to include protection of foraging areas and food plants as a priority 1 task in the lesser long-nosed bat recovery plan.

Mortality of leaf succulents exposed to fire is extremely variable. The Baker prescribed fire was conducted recently in the southern Peloncillo Mountains in extreme southeastern Arizona and southwestern New Mexico. According to preliminary monitoring efforts conducted after the fire, there were seven to 11 percent mortality of Palmer's agaves exposed to fire (Peter Warren, pers. comm. 1997). Additional mortality may accrue through loss of the smallest and least detectable size classes of agave. On the Maverick Prescribed Fire, also in the Peloncillo Mountains, less than five percent of agaves in burned areas were killed by the fire. Because of a mosaic of burned and unburned areas, overall mortality in the project area was perhaps less than one percent (T. Roller, pers. comm. 1998). Thomas and Goodson (1992) reported an average mortality of 28 percent of five species of leaf succulents from nine burned sites in southern Arizona. Palmer's agave mortality averaged 18 percent. However, post-fire grazing may have influenced reported mortality. Concentrations of paniculate agaves are primarily on the rocky, shallow soils of hills and ridges, particularly on southerly and southeasterly facing slopes. Other Palmer's and Parry's agaves are found scattered in areas of deep, heavy soils

where thick stands of shrubs and mesquite form heavy fuel loads. The relative fuel loading and potential exposure of agaves to intense fire is lower on rocky soils.

Agave mortality due to fire may affect the abundance and distribution of blooming agaves on the landscape for many years into the future, especially if there is high mortality within certain age/size classes (e.g seedlings). In addition, natural recruitment of agaves may be very episodic and the effects of fire on the agave seed bank in the soil are unknown. Often one of the objectives of prescribed fire is to increase abundance of grasses. Grasses are probably one of the strongest competitors with agave seedlings (Tony Burgess, pers. comm. 1997). Increased abundance of grass could result in reduced agave abundance. Agave stalks, as they begin to bolt, are particularly palatable to domestic livestock and wild herbivores, including deer, javelina, rodents, and rabbits (Michelle Hawks, University of Arizona, Tucson, pers. comm. 1997; Wendy Hodgson, pers. comm. 1997). Since agaves often remain partially green, succulent, and available to herbivores when food resources are low immediately following a fire, they may be preferentially selected by herbivores. This may in turn affect the availability of agave flowering stalks to bats.

Besides direct mortality of agaves, fire may alter the availability of blooming agaves. By early spring, an agave plant would have physiologically committed to bolt (send up a flowering stalk). If the plant is burned and lives, bolting continues though the flower stalk is smaller with fewer flowers (Howell 1996; Liz Slauson, pers. comm. 1997). If the stalk burns directly, the reproductive effort of that plant and the availability of flowers and nectar to *Leptonycteris* has been lost. A fire may actually stimulate flowering in adult agaves one to two years following a burn (Liz Slauson pers. comm. 1997). However, in subsequent years following the period of increased flowering there may be a reduced number of flowering agaves. Although the availability of blooming agaves may be affected by fire, the nectar production and sugar content of surviving plants is little effected. Working in the Peloncillo Mountains, Slauson (pers. comm. 1997) found that nectar production and sugar content did not differ between unburned agaves and burned agaves that did not have greater than 80-90 percent of the leaf area burned. The complexity of variables influencing agave flowering may mask the effects of a burn on agave flowering within several years of a fire.

Reintroducing fire into fire-adapted communities, such as desert grassland and oak/juniper savanna systems, can also have many benefits and may improve overall long-term "ecosystem management" objectives. Among these is the reduction of woody fuels resulting in decreased probability of intense fires and resulting erosion, soil sterilization, and increased plant mortality. Ultimately, if fire continues to be excluded from fire-adapted systems a major wildfire will occur with potentially devastating effects. Returning to a more natural regime of low-intensity fires would help to maintain a mosaic of grasslands, woodlands, and shrublands across the landscape and may enhance refugia in which fuel loads and the chances of damaging

fires are low. However, even under a prescribed fire regime there are potential adverse effects of fire to forage plants that may affect resource availability for the lesser long-nosed bat.

Activities that directly or indirectly promote invasion or increased density of nonnative grasses, particularly Lehmann lovegrass, may result in increased fire frequency or intensity, reduced densities of Palmer's agave, and thus reduced forage resources for the lesser long-nosed bat. Lehmann lovegrass is abundant in some portions of the West and South ranges at Fort Huachuca. This species increases after fire (Ruyle *et al.* 1988, Sumrall *et al.* 1991, Martin 1983, Howell 1996), but also produces an abundance of fine fuel that promotes hot fires (McPherson 1995). Thus, frequent fire is likely to increase the abundance of Lehmann lovegrass, and increased abundance of this grass will likely fuel more fires and hotter fires, creating a positive feedback loop (Anable *et al.* 1992). Frequent, hot fires brought about by prescribed fires and increasing prevalence of Lehmann lovegrass will likely reduce densities of Palmer's agave. Howell (1996) found that Lehmann lovegrass creates areas of continuous fuels at Fort Huachuca that burn at a constant temperature versus stands of native grasses that are patchy in regard to fuels and fire intensity. Agaves can persist in fire-prone native grasslands in bare areas or refugia that burn lightly or not at all. Such refugia are less common in Lehmann lovegrass stands. Howell (1996) also noted a negative relationship between the proportion of agave seedlings and ramets and the amount of Lehmann lovegrass. She suggested that Lehmann lovegrass appears to suppress agave recruitment independent of the fire effects just described. The mechanism of suppression is unclear, but Howell (1996) suggests Lehmann lovegrass may compete effectively with agaves for nutrients and/or light. If agave densities are reduced due to elevated fire effects or recruitment suppression caused by Lehmann lovegrass invasion, forage resources of the lesser long-nosed bat will be reduced.

Howell (1996) found that a fire frequency of three to six per decade on the South Range is "clearly too high to allow sexual reproduction to persist in the agave community...too high to permit seedling establishment and too high to allow even the fast growing clones to achieve reproductive status." Howell (1996) suggested that fires be managed on the South Range to approximate the natural fire frequency, which is likely 10-15 years (8-22 years range). She also recommended suppressing fires in plots with demography biased towards young and/or middle age class agaves, because of their sensitivity to fire damage. Examination of Figure 7 reveals that some areas of the South Range, and fewer areas on the West Range, burned six to eight times from 1973-1993, which is, according to Howell (1996), too often for healthy agave stands. Most of the West Range, and large portions of the eastern and southern parts of the South Range burned at approximately the 10-15 year frequency recommended by Howell (1996). Overlaying Figure 7 on Figure 8 shows that from 1973-1993 the agave management areas on the South Range generally burned more frequently than recommended by Howell (1996). On the West Range, agave management areas generally burned from 0-3 times during 1973-1993, with most burning less than twice, or generally within the recommendations of Howell (1996). As discussed, the relationship of fire frequency and intensity to agave population dynamics is complex. The Fort has proposed suppressing fires in agave

management areas unless the area is approaching its natural fire return interval of 10 years (Appendix 1). The Service further recommends adaptive management in regard to fire management to ensure maintenance of viable, healthy agave populations.

The importance of Parry's agave stands in the Huachuca Mountains as a forage resource for the lesser long-nosed bat is unknown. As discussed, Parry's agave generally occurs at higher elevation than Palmer's agave, and occurs in forest openings throughout the Huachuca Mountains to the mountain's crest. Benson and Darrow (1982) note that it typically flowers in June and early July, which is before the lesser long-nosed bat arrives at roosts at Fort Huachuca. However, J. Rorabaugh (pers. comm. 1998) noted many Parry's agave in flower high in the Huachuca Mountains on the crest trail during late July in 1997. It may be that agaves at high elevation bloom later than at lower sites, and could potentially be blooming and be used as a forage resource when lesser long-nosed bats arrive in July or early August.

The only significant threat to stands of agaves in the forested portions of the Huachuca Mountains is fire. As discussed for the Huachuca water umbel, peregrine falcon, and Mexican spotted owl, fuel loads are high in some portions of the Huachuca Mountains, and a stand-replacing, catastrophic wildfire could occur due to lightning strikes or project-related causes such as a careless recreationist or ordnance. Because Parry's agave occurs primarily in openings and often on rocky slopes where fuel loads are relatively light, agave populations may not be severely directly affected by wildfire. Openings created by fire could conceivably increase habitat for agaves, temporarily. However, post-fire erosion of slopes could bury or scour hillsides and rocky places where agaves occur. The Fort will be implementing a Fire Management Plan to reduce fuel loads and the chance of catastrophic fire in the Huachuca Mountains. With implementation of this plan, threats to agave populations posed by wildfire would be reduced.

Predation of agaves by gophers and ungulates on the West Range was found to be inhibiting sexual reproduction of agaves. Howell (1996) suggested that if areas of the West Range are to be managed for agaves "attention will have to be paid to the intense predation." Predator control (coyotes and other carnivores) has been carried out on the South Range for 12-14 years in an attempt to increase populations of Chihuahuan pronghorn. Reduced predator densities could theoretically contribute to increased populations of gophers and ungulates that in turn result in increased predation of agaves. However, Howell (1996) found no correlation between predator control activities and agave demographics on the West versus the South ranges, and predation of agaves appeared to be higher on the West Range where predator control has not been implemented.

Implementation of Howell and Robinett's (1996) agave management plan, as proposed by the Fort (Appendix 1), would provide good protection for key agave stands and bat foraging areas

in the lower elevation areas of Fort Huachuca. The plan provides for minimizing or eliminating possible adverse effects of training activities, provides a means for fire to play a more natural role without inhibiting agave population health or viability, and sets up an administrative network and environmental education programs to ensure that protective measures are carried out. However, the Service believes some flexibility should be built into the plan and the recommendation to apply prescribed fire only from November through March in the agave management areas may not be necessary to maintain healthy and viable agave populations. As demonstrated in the Baker and Maverick fires in the Peloncillo Mountains, warm season fire may not result in significant mortality. Exclusion of fire during the warm season could encourage invasion of woody species. However, cool season burns may be warranted to protect small size classes of agaves, particularly if Lehmann lovegrass is present, which could increase fire intensity. As discussed, due to uncertainties and the need to make changes as monitoring data and new research results become available, the Service favors an adaptive management approach in which management of key agave stands would evolve with new information.

Howell (1992) examined the effects of UAV (Sky Owl and Hunter) testing on the lesser long-nosed bat at Fort Huachuca. Fort Huachuca proposes testing of the Pioneer and Hunter UAVs (SAIC 1998a); the Pioneer and Sky Owl are both relatively small UAVs and very similar in regard to noise output. Howell (1992) concluded that lesser long-nosed bats would not hear noise of UAVs cruising at 1,000 to 3,000 feet AGL. Currently, typical cruising elevation is above 3,500 feet AGL, with some flights as low as 1,000 feet (and some infrequent low-level flights - see "Effects of the Proposed Action" for the peregrine falcon and Mexican spotted owl). Noise generated by UAVs is relatively low intensity. Also, lesser long-nosed bats are not very sensitive to sounds below frequencies of 10 kHz (Howell 1974). The high frequency sounds to which the bat is sensitive attenuate very rapidly with distance (Howell 1992). Thus, noise generated by typical UAV flights over Fort Huachuca, to the Canelo Hills, the Altar Valley, or other destinations should not disturb foraging or roosting lesser long-nosed bats.

Noise is also generated during rolling or rocket-assisted take-off of UAVs. Most proposed UAV take-offs and landings would occur on the Pioneer and Rugge-Hamilton (formerly Raven) airstrips at the Black Tower Complex on the West Range, but occasional take-off and landings would occur at the Hubbard airstrip. The Hunter UAV uses the Rugge-Hamilton strip, whereas the smaller Pioneer uses the Pioneer strip. Howell (1992) concluded that UAV take-off at Hubbard airstrip would not affect lesser long-nosed bats because agaves are scarce to non-existent in that area and the airstrip is over nine miles from known roosts. However, good stands of agaves are present near the Black Tower UAV facility, and bats probably forage near the facility. In regard to rocket-assisted take-off, Howell (1992) found that noise generated is well above the minimal noise that triggers a response in the bat's auditory system. She recommended that nocturnal rocket-assisted take-offs of UAVs from Black Tower only occur from November through May to avoid the season when the bat is present at Fort Huachuca. Howell (1992) also recommended that rocket-assisted take-offs be attended by fire

crews due to the high probability of fire and potential adverse effects to agave communities. The Fort has adopted these recommendations (Appendix 1), except that rocket-assisted take-offs may occur through June. This is an appropriate modification because lesser long-nosed bats have not been recorded at Fort Huachuca before late July. The Fort has also adopted policies calling for nocturnal flights of UAVs to be above 500 feet from July 1 to October 31, and take-off and landing approaches at Rugge-Hamilton and Pioneer airstrips would be modified to avoid flying low-level over agave management areas (Appendix 1).

UAVs crash on or off-post approximately once per year. There have also been two manned aircraft crashes at Fort Huachuca (at Libby Airfield) in the past ten years. Search and rescue operations are carried out for manned aircraft that crash, and aerial or ground searches occur following crashes of UAVs. Some potential exists for aircraft crashes to directly impact agaves or to start fires that affect agaves. The potential for a crash to directly affect a roost site on or off-post is very small.

Disturbance of bats as a result of noise could also occur due to low-level fixed-wing and helicopter flights, small arms or other weapons fire associated with military training, or discharge of a firearm by a hunter. Dalton and Dalton (1993) investigated the effects of low-level (500 feet AGL) military jet flights on the lesser long-nosed bat in a mine that served as a day roost at Organ Pipe Cactus National Monument. Bats exposed to low-level flights exhibited no acute responses (panic flights, falling young bats, or startle responses). No significant differences in bat orienting responses were noted before, during, or after jet flights, but depressed levels of bat flights were noted for up to 30 minutes following the jet noise. Low-level jet noise attenuated rapidly within the roost, particularly the high frequency sounds to which bats are particularly sensitive. The authors note that extrapolation of the results to other sites with different terrain or mine tunnel geometry may not be valid. They also find that the study did not address any potential long-term effects to the bat colony. As discussed in the Effects of the Proposed Action for the peregrine falcon, wildlife typically respond more to helicopter flights than fixed-wing aircraft. A helicopter flying very low over a bat roost could produce noise as well as high winds that could disturb bats.

The findings of Dalton and Dalton (1993) combined with the apparent infrequency of low-level flights at Fort Huachuca suggest that noise from overflights probably does not significantly adversely affect lesser long-nosed bats that are roosting deep in a mine or cave, at least in the short-term. Low-level nocturnal military flights may affect bats that are foraging or night roosting differently, and as Dalton and Dalton (1993) note, the long-term effects of repeated low-level flights are unknown. Again, however, the infrequency of low-level flights at Fort Huachuca reduces the probability of this being a significant adverse effect.

Hunting is allowed in the vicinity of the three known lesser long-nosed bat roosts. Potentially, a hunter could discharge a weapon near the entrance to a roost site and disturb bats or cause them to temporarily abandon the roost. However, this type of disturbance is likely to be infrequent. Most hunting occurs after the bats have left in late September or early October.

Noise from military weapons fire is unlikely to disturb lesser long-nosed bats. Small arms firing would occur on the South Range; however, the firing ranges are all at least 5.6 miles from Pyeatt Cave and Manila Mine, and over three miles from Wren Bridge. Noise from weapons fire would attenuate dramatically over that distance, particularly the high frequencies. Artillery and mortar firing occurs at several areas on the East Range. Ordnance is directed eastward from these sites and is delivered into Area ZULU, also on the East Range. Noise from these sources is louder than the small arms firing on the West Range. However, mortar and artillery firing on the East Range occur at a much greater distance from the known bat roosts. All mortar and artillery firing sites and the impact zone in Area ZULU are more than 6.2 miles from Wren Bridge and more than 7 miles from Pyeatt Cave and Manila Mine. No effects to lesser long-nosed bats are anticipated as a result of mortar and artillery firing on the East Range.

Mortality or injury of lesser long-nosed bats could also occur due to collisions with vehicles, aircraft, ordnance, power/communications lines, or other project features on Fort Huachuca. The frequency of such collisions is unknown, but the Service believes this type of take is likely to occur at least once over the life of the project. The Fort has proposed no nighttime training in agave management areas from July 1 through October 31, no nighttime use and no tracer fire on live fire ranges 2, 3, and 4 from July 1 through October 31, no use of pyrotechnics within 0.25 mile of agave management areas, and no off-road vehicle use and restrictions on low-level flights nocturnal over agave management areas, which collectively greatly reduce the likelihood of take resulting from collisions.

Cattle grazing can adversely affect agave survivorship and bolting. Prior to the summer monsoons at Four Peaks on Tonto National Forest, cattle were observed eating the unprotected apex of several agave plants (Tricia Roller, Service, Tucson, AZ pers. comm. 1997). Cattle probably trample young agaves, as well. Although cattle have been excluded from Fort Huachuca for many years, grazing by horses occurs on 1,433 acres of the West Range within 0.6 mile of protected agave stands and Wren Bridge. The horse pastures are approximately three miles from Manila Mine and Pyeatt Cave. Thus, the grazed area is likely foraging habitat for the lesser long-nosed bat. There are some differences in grazing behavior between horses and cattle. It is unknown whether horses browse agave bolts, but if they do, forage resource availability for the bat would be reduced by such browsing. Horses, like cattle, probably also trample young agaves and may compact soils and reduce germination and survival. Although horses tend to avoid areas of high densities of agaves (Howell and Robinett 1996), any trampling or browsing of agaves would reduce forage resources available

to the lesser long-nosed bat. Direct effects due to grazing may be more intense in areas grazed during the flowering season of the agave (primarily Area C) and where horses congregate near water sources.

The Fort proposes a number of building/construction projects over the next five years (Table 3). Most of these would occur in the cantonment area in previously disturbed areas, or would constitute improvements to existing structures. Few if any of these projects have potential to disturb habitats that may contain agaves. An exception may be the recreational vehicle park expansion on the northwestern side of the cantonment area. However, the expansion is small, and any effects to bat forage resources at Fort Huachuca would be relatively very small. The Fort has adopted measures to ensure minimal disturbance of lesser long-nosed bat foraging habitat during construction activities (Appendix 1).

Some training activities, such as bivouacs, ordnance delivery, and other activities that may result in disturbance could damage or destroy agaves, or result in soil compaction and reduced agave establishment. However, personnel are instructed to avoid disturbance to agaves, nearly all such training occurs at established sites or previously-disturbed areas, areas directly disturbed by ordnance delivery are relatively small (fire effects of ordnance delivery are discussed above), the most significant stands of Palmer's agave are well-protected from training activities in the agave management areas, and very little training occurs in the habitat of Parry's agave.

The Fort is considering a land exchange in which 26 acres near Kayetan Drive and Buffalo Soldier Trail would be exchanged for Arizona state land parcels in the East Range. State land parcels in the East Range probably have little development potential because of their location in an active military range. However, the 26 acres which may be exchanged to the State could be developed. The City of Sierra Vista planning department indicates that the most likely use of the land is commercial or light industrial (Jim Hessil, pers. comm. 1998). If all or part of the 26 acre parcel is developed, some foraging habitat of the bat could be lost. It is unknown whether agaves occur on the parcel, but it is rather low on the bajada where agaves are uncommon or absent.

Off-post activities are unlikely to affect lesser long-nosed bats or their habitat. These activities occur in previously-disturbed areas. As discussed for the southwestern willow flycatcher, activities off-post could potentially increase the chances of fire, which may adversely affect agave plants and bat forage resources. Also, some off-post training activities involve use of antennas with which bats might collide, and vehicles traveling to and from remote sites could potentially collide with a foraging lesser long-nosed bat.

Interrelated and Interdependent Effects

As discussed for the Huachuca water umbel and the southwestern willow flycatcher, some of the existing development and population in the Sierra Vista area can be attributed to Fort Huachuca, because some employees, contractors, military dependents, military retirees, and others live in the Sierra Vista area because of job opportunities or military benefits provided by the Fort (Fort Huachuca 1997b). Thus, some of the residents and development off-post would not be there but for the presence of Fort Huachuca. Some of this development may have resulted in destruction of lesser long-nosed bat foraging habitat. However, the best agave populations appear to be concentrated on the upper bajadas, while most of the development has occurred lower on the slope where agaves are uncommon. Also, as discussed for the umbel and the flycatcher, predicted growth in the Sierra Vista area may not be attributable to Fort Huachuca because number of personnel at the Fort is predicted to be static over the near term (SAIC 1998a).

Cumulative Effects

Cumulative effects are those adverse effects of future non-Federal (State, local government, and private) actions that are reasonably certain to occur in the project area. Future Federal actions would be subject to the consultation requirements established in section 7 of the Act and, therefore, are not considered cumulative to the proposed project. Effects of past Federal and private actions are considered in the Environmental Baseline. Much of the land in the project area is managed by Federal agencies, particularly the BLM, Coronado National Forest, and Coronado National Memorial. The only significant known roost in the Huachuca Mountains outside of Fort Huachuca is the State of Texas Mine on the Coronado National Memorial. Activities on State and private lands may require permits or funding from Federal agencies. Thus, many of the actions that are reasonably expected to occur in the project area that may adversely affect the lesser long-nosed bat would be subject to section 7 consultations. However, grazing, development, and other activities occur on large tracts of State and private lands within the project area and within the known range of the lesser long-nosed bat that are not interrelated or interdependent to the Fort's activities and are not otherwise subject to section 7. The effects of these activities are considered cumulative to proposed action. Development near the base of the Huachuca Mountains or at the mouths of canyons on the east slope south of Fort Huachuca could result in destruction of bat foraging habitat and agaves. Compliance with the Act for activities on State and private lands that may affect the lesser long-nosed bat, but are not addressed by section 7 consultation, could occur through section 10(a)(1)(B) of the Act.

Effectiveness of Proposed Mitigation

The Service and the Fort have exchanged considerable correspondence over the past nine years on lesser long-nosed bat concerns. As a result, the Fort has developed many valuable measures to protect the lesser long-nosed bat and its habitat. Some of these were recommended by the Service to the Fort to reduce the likelihood of take; they were subsequently adopted by the Fort as part of their proposed action. Others have been in place for many years. These measures are found in Appendix B of the MOA (Appendix 1 herein) and can be summarized as follows:

- 1) ensure road maintenance or construction does not increase or facilitate public access to day roosts of lesser long-nosed bat
- 2) consider the use of bat gates on day roosts used by lesser long-nosed bat
- 3) ensure alarm systems are functional, access routes to day roosts are closed from at least July 1 - October 31 and roosts are posted with signs
- 4) take corrective action to correct any increase in illegal entry into day roosts
- 5) prohibit low-level helicopter flights within 350 feet of day roosts from July 1 through October 31
- 6) conduct pre-construction surveys for paniculate agaves to minimize disturbance or damage to agaves that are present
- 7) no planting or seeding of nonnative grasses or plants will occur on Fort Huachuca that may alter fire frequency in wildland areas
- 8) fire management activities will be planned to minimize adverse effects to lesser long-nosed bat forage and roosting habitats
- 9) no more than 20 percent mortality of agaves during managed fire activities
- 10) fires in agave management areas will be suppressed unless approaching a 10 year fire interval
- 11) prohibit managed fire activities in agave management areas where greater than half of the agaves are young age classes
- 12) prepare a mitigation plan for managed fire activities within 0.5 mile of a bat roost or areas that support paniculate agaves
- 13) protection of lesser long-nosed bat foraging and roosting habitats will be an objective of all fire management activities
- 14) provide a natural resource advisor who will be present during all fire management activities

- 15) areas of significant human activity during fire activities will not be located within 0.25 mile of day roosts from July 1 - October 31, and disturbed areas will be minimized
- 16) minimize off-road vehicle use during fire activities, to include the use of tracked vehicles
- 17) prohibit night time training in agave management areas from July 1 - October 31
- 18) night time use and tracer fire will be prohibited on live fire ranges 2, 3 and 4 from July 1 through October 31
- 19) from July 1 - October 31, all nocturnal UAV operations at Rugge-Hamilton and Pioneer sites will be above 500 feet above ground level, except for take-off and landing approaches. Take-off and landing approaches at Rugge-Hamilton will be confined to the east and north and approaches at Pioneer will be confined to the north and west, away from agave management areas. Nocturnal rocket-assisted take-offs at the Black Tower site shall only occur from November through June.
- 20) off-road vehicle use is prohibited in agave management areas or any part of the West and South Ranges
- 21) pyrotechnics are prohibited within 0.25 mile of agave management areas
- 22) implement the Agave Management Plan to ensure continued protection of agave populations from natural and human threats
- 23) conduct annual monitoring of known or potential lesser long-nosed bat roosts on Fort Huachuca
- 24) conduct monitoring of Palmer's agave populations on the West and South Ranges every five years
- 25) prepare annual monitoring report for the Service by January 31 of each year
- 26) provide environmental awareness training to personnel whose actions have the potential to affect lesser long-nosed bat roosting and foraging habitat
- 27) require that training and testing in agave management areas, to include personnel on foot, be conducted with a Range Control Office approved plan for fire suppression and appropriate fire fighting equipment

The Service believes the above measures will largely reduce or eliminate most potential adverse effects to the lesser long-nosed bat as a result of the proposed action. Gating, signing, and restricting access seasonally has been successful in nearly eliminating human disturbance at bat roosts. However, the current system does not prevent illegal entry to bat roosts. By the time the alarm system detects an intruder and military police can respond, considerable disturbance to the bats may have already occurred. Bat gates with lockable human access doors would be more effective and eliminate the need for an alarm system; however, the Service is concerned about the possible effects that bat gates may have on use of roosts by lesser long-nosed bats. Gating designs are being tested at the State of Texas Mine at Coronado

National Memorial and should provide further insight into how bat gates should be used for this species.

Noise from aircraft and weapons fire is regulated, too distant from bat roosts or foraging areas, or in the case of low-level helicopter flights, is infrequent enough to be minimally disturbing to lesser long-nosed bats. By not operating UAVs at night below 500 feet above ground level from July 1 to October 31, the Fort has implemented Howell's (1992) recommendations in regard to UAV flights. The most important stands of Palmer's agave are protected from too-frequent fire and training activities by a variety of measures.

As discussed in the Effects of the Proposed Action in regard to fire in agave management areas, the Service believes the relationships between fire frequency, intensity, and seasonality and agave population dynamics are complex. The recommendations of the Howell and Robinett (1996) (the Agave Management Plan) as to how agave management areas should be managed are generally a good starting point, but the Service believes the Fort should practice adaptive management and use monitoring data and research results to further fine tune these recommendations. Howell and Robinett's (1996) recommendation to not burn during the warm season in agave management areas is probably not warranted in most areas, based on findings in the Peloncillo Mountains. However, cool season burns may be needed in specific sites to protect younger size classes of agaves, particularly if Lehmann lovegrass is common.

The timing or seasonality of when specific mitigation measures would apply is July 1 through October 31. This encompasses the period when lesser long-nosed bats have been observed at Fort Huachuca (July 6-October 22). Numbers typically peak in early September (Sidner 1999). Fleming (1995) notes that male lesser long-nosed bats arrive at East Whitetail Canyon in the Chiricahua Mountains as early as late April; however, Sidner (1996, 1999) has monitored roosts at Fort Huachuca in May and June without finding lesser long-nosed bats. Sidner's roost surveys suggest that a sensitive period for the bat, when activities should be actively managed to protect roosts and foraging bats, should be July 1 to October 31, as proposed by the Fort. Closure of roosts to cavers earlier in the season may be appropriate to protect other non-listed species of bats that arrive sooner, such as pallid bats, *Antrozous pallidus*, and *Myotis velifer*.

CONCLUSION

After reviewing the current status of the lesser long-nosed bat, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of lesser long-nosed bat. No critical habitat has been designated for the lesser long-nosed bat; thus none will be affected. We present this conclusion for the following reasons:

1. The proponent's proposed action includes many features to minimize take of lesser long-nosed bats and mitigate the direct and indirect impacts of the proposed action on the lesser long-nosed bat and its foraging and roosting habitats.
2. The project area in which most activities occur covers a relatively minor portion of the total range of the lesser long-nosed bat.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Harass is defined in the same regulation by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take of a listed animal species that is incidental to, and not the purpose of, the carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of sections 7(b)(4) and 7(o)(2) of the Act, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by Fort Huachuca so that they become binding conditions of any grant or permit issued to any applicant, permittee, or contractor, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Fort has a continuing duty to regulate the activity covered by this incidental take statement. If the Fort (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant, permittee, or contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Fort Huachuca must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

The Service anticipates the following incidental take of lesser long-nosed bats as a result of authorized activities that are part of the proposed action:

- 1) Six lesser long-nosed bats over the life of the project in the form of direct mortality or injury as a result of collisions with vehicles, aircraft, antennas, fences, and other project features.
- 2) Twenty lesser long-nosed bats per year as a result of harassment due to noise associated with military training, hunter weapons fire, and military overflights.
- 3) Ten lesser long-nosed bats over the life of the project as a result of harm due to loss of forage plants due to prescribed fire, wildfire suppression, wildfire caused by authorized activities, grazing by horses as described in the proposed action, construction activities, training, and subsequent development on a 26-acre parcel proposed for exchange.
- 4) All bats in a day roost, twice during the life of the project, in the form of harassment as a result of illegal human entry into day roosts.

The Service believes take of lesser long-nosed bats will be difficult to detect for the following reason(s): the bat is wide-ranging and may use more than one roost; it has a small body size; thus finding a dead or impaired individual is unlikely; losses may be masked by seasonal use of roosts; and the species occurs in habitats that makes detection difficult. Therefore, we have defined the following parameters, that in addition to the above numbers of bats, will be used as indicators that anticipated incidental take has been exceeded.

- 1) A significant increase in annual illegal entry into lesser long-nosed bat roosts (Pyeatt Cave and Manila Mine, or other sites where lesser long-nosed bats are confirmed during the life of the project) occurs without the Fort taking remedial action to correct the problem.
- 2) Fire occurs in agave management areas during the life of the project that results in average fire frequencies within a management area during the previous 20 years that exceed one fire in 10 years, and the Fort does not take action to correct the problem.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the

proposed action. This biological opinion does not authorize any form of take **not** incidental to the Fort's proposed action as described herein. Although the Service anticipates take associated with unauthorized entry into roosts, the Service does not authorize such take under this take statement.

EFFECT OF THE TAKE

In this biological opinion, the Service finds that this level of anticipated take is not likely to jeopardize the continued existence of the lesser long-nosed bat.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measure is necessary and appropriate to minimize impacts of incidental take authorized by this biological opinion:

Prompt implementation of proposed mitigation measures.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Fort must comply with the following term and condition in regard to the proposed action. This term and condition implements the reasonable and prudent measure described above. Terms and conditions are nondiscretionary.

The Fort shall promptly implement measures 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, and 17 of the "Proposed Mitigation Measures" in the "Description of the Proposed Action" herein, and mitigation measures specific to the lesser long-nosed bat, as well as general mitigation measures and reporting requirements in Appendix B of the MOA (Appendix 1 herein).

If the incidental take anticipated in the paragraph entitled "Amount or Extent of Take" is met, the Fort shall immediately notify the Service in writing. If, during the course of the action, the level of anticipated incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation. In the interim, the Fort must cease the activity resulting in the take if it is determined that the impact of additional taking will cause an irreversible and adverse impact on the species. Fort Huachuca must immediately provide an explanation of the

causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information on listed species. The recommendations provided here do not necessarily represent complete fulfillment of the agency's section 2(c) or 7(a)(1) responsibilities for the lesser long-nosed bat. In furtherance of the purposes of the Act, we recommend implementing the following actions:

1. The Fort should investigate the importance of Parry's agave as a forage resource for the lesser long-nosed bat.
2. The Fort should continue to investigate the fire ecology of paniculate agaves.
3. The Fort should investigate and monitor the invasion of Lehmann lovegrass at Fort Huachuca and assist other agencies in developing methods for controlling this nonnative grass.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitat, the Service requests notification of the implementation of any conservation recommendations.

(Note: surveys for lesser long-nosed bats, or other bats, that involve capture or take require appropriate permits from the Service and Arizona Game and Fish Department.)

Sonora tiger salamander

STATUS OF THE SPECIES

The Sonora tiger salamander is a large salamander with a dark venter and light-colored blotches, bars, or reticulation on a dark background. Snout-vent lengths of metamorphosed terrestrial salamanders vary from approximately 2.6-4.9 inches (Jones *et al.* 1988, Lowe 1954). Larval salamanders are aquatic with plume-like gills and well-developed tail fins (Behler and King 1980). Larvae hatched in the spring are large enough to metamorphose into terrestrial salamanders from late July to early September, but only an estimated 17 to 40 percent metamorphose annually. Remaining larvae mature into branchiates (aquatic and larval-

like, but sexually mature salamanders that remain in the breeding pond) or over-winter as larvae (Collins and Jones 1987; James Collins, Arizona State University, pers. comm. 1993). The Sonora tiger salamander was listed as endangered on January 6, 1997. No critical habitat has been proposed or designated. A recovery plan is currently in preparation by Dr. James Collins and Jon Snyder, Arizona State University. A Participation Team of stakeholders and other individuals knowledgeable about the salamander and its habitat are assisting Dr. Collins and Mr. Snyder.

The Sonora tiger salamander is known from approximately 53 breeding localities (Collins and Jones 1987, Collins 1996, US Fish and Wildlife Service 1997, Abbate 1998, Ziemba et al. 1998, Jon Snyder, Arizona State University, pers. comm., 1999; Mike Pruss, Arizona Game and Fish Department, pers. comm. 1999); although at any one time not all of these sites are occupied. During intensive surveys in 1997, from one to 150 Sonora tiger salamanders were found at 25 stock tanks (Abbate 1998). Populations and habitats are dynamic, thus the number and location of extant aquatic populations changes over time, as exhibited by the differences between survey results in 1985 and 1993-1997 (Collins and Jones 1987, Collins 1996, James Collins, pers. comm., 1996, Ziemba et al. 1998, Abbate 1998). Some sites that once supported salamanders are now inhabited by nonnative predators that preclude recolonization.

Salamanders that may be Sonora tiger salamanders have also been found at the lower Peterson Ranch tank in Scotia Canyon, upper Garden Canyon Pond at Fort Huachuca, and at Los Fresnos in the San Rafael Valley, Sonora. Salamanders have not been found at the Scotia Canyon site for several years; this population may be extirpated. Additional reports of the salamander from one mine, one cave, and one spring-fed well have yet to be confirmed (Ziemba et al. 1998). All sites where Sonora tiger salamanders have been confirmed are located in the San Rafael Valley and adjacent portions of the Patagonia and Huachuca mountains in Santa Cruz and Cochise counties, Arizona. All confirmed historical and extant aquatic populations are found in cattle tanks or impounded cienegas.

Historically, the Sonora tiger salamander probably inhabited springs, cienegas, and possibly backwater pools that were extant long enough to support breeding and metamorphosis (at least two months), but ideally were permanent or nearly permanent, allowing survival of mature branchiates. The grassland community of the San Rafael Valley and adjacent montane slopes, where all extant populations of Sonora tiger salamander occur, may represent a relictual grassland and a refugium for grassland species. Tiger salamanders in this area became isolated and, over time, genetically distinct from ancestral *A. t. mavortium* and *A. t. nebulosum* (Jones et al. 1995). Contrary to the statement in SAIC (1998a) that "these salamanders in Arizona were introduced into stock tanks by humans", genetic work by Jones et al. (1995) suggests the subspecies known as the Sonora tiger salamander originated in the San Rafael Valley, and was not introduced by humans. This subspecies has opportunistically taken advantage of available stock tank habitats as natural habitats disappeared (Hendrickson and Minckley 1984) or were

invaded by nonnative predators with which the salamander can not coexist (US Fish and Wildlife Service 1997).

Primary threats to the salamander include predation by nonnative fish and bullfrogs, a disease, catastrophic floods and drought, illegal collecting, introduction of other subspecies of salamanders that could genetically swamp *A. t. stebbinsi* populations, and stochastic extirpations or extinction characteristic of small populations with low genetic variability. Predation by catfish, bass, mosquito fish, and sunfish can eliminate stock tank populations of Sonora tiger salamander (Jonathan Snyder, Arizona State University, pers. comm. 1996; Collins *et al.* 1988). The salamanders can apparently coexist with bullfrogs, but bullfrogs prey on salamanders (J. Snyder, pers. comm. 1996) and perhaps if they are present in sufficient densities could reduce or eliminate salamander populations. Tadpoles of wood frogs, *Rana sylvatica*, are known to feed on spotted salamander, *Ambystoma maculatum*, eggs (Petranka *et al.* 1998), but under experimental conditions bullfrog tadpoles do not feed on viable salamander eggs or hatchlings (Collins 1996, J. Collins, pers. comm. 1996). A disease, recently identified as an iridovirus, has been documented at numerous tanks in the San Rafael Valley (Jancovich *et al.* 1998). Once introduced to a stock tank, most or all aquatic salamanders die (Collins *et al.* 1988, Jancovich *et al.* 1998). The disease may be spread by birds, cattle, or other animals that move among tanks (Jancovich *et al.* 1998). The disease could also be spread by researchers if equipment such as waders and nets used at a salamander tank are not disinfected or allowed to thoroughly dry before use at another tank. Diseased salamanders were found at two tanks in 1997 (Abbate 1998).

Ambystoma tigrinum mavortium or *stebbinsiXmavortium* crosses have recently been confirmed for the first time at two stock tanks in the San Rafael Valley (Ziemba *et al.* 1998). Thus, genetic swamping of *stebbinsi* populations may be underway. With the exception of Bog Hole in the San Rafael Valley and a site on Fort Huachuca, cattle grazing occurs throughout the range of the Sonora tiger salamander. Cattle can trample salamanders and their eggs, and can degrade habitat at stock tank breeding sites. Overgrazing can cause loss of cover and erosion that can threaten the integrity of stock tanks used by the salamander. Genetic analysis suggests very little genetic variability in Sonora tiger salamanders (Jones *et al.* 1988, Jones *et al.* 1995, Ziemba *et al.* 1998). In populations with low genetic variability lethal alleles are more likely to be expressed, disease resistance may be low, and evolution and adaptation to a changing environment is relatively slow.

For further information on the ecology, taxonomy, range, and threats to this subspecies, refer to Collins (1981, 1996), Collins and Jones (1987), Collins *et al.* (1988), Gelbach (1967), Jancovich *et al.* (1998), Jones *et al.* (1988, 1995), Lowe (1954), Snyder *et al.* (1996, 1998), and Ziemba *et al.* 1998.

ENVIRONMENTAL BASELINE

On Fort Huachuca, tiger salamanders are known from upper Garden Canyon Pond near the crest of the Huachuca Mountains and the junction of Sawmill and Garden canyons, and also from the wastewater treatment ponds and the golf course. In 1998, salamanders were collected from the upper Garden Canyon Pond and from the wastewater treatment ponds. Mitochondrial DNA sequencing and allozyme analysis of salamanders from the wastewater treatment plant suggests that these salamanders are *Ambystoma tigrinum mavortium*. Analysis of salamanders from upper Garden Canyon pond was less clear. These animals showed a high level of heterozygosity, which is uncharacteristic of *A. t. stebbinsi*, but the mitochondrial DNA sequencing suggested these animals are identical to the majority of *stebbinsi* populations in the San Rafael Valley. A canabalistic morph was also found at upper Garden Canyon pond, which is highly unusual for *stebbinsi* populations, but a common occurrence in populations of *A. t. mavortium*. These salamanders could be hybrids between the two subspecies, but available data are inadequate to make this determination (Storfer *et al.* 1999.) Additional genetic work, using microsatellite analysis, is underway to clarify the taxonomy of this population. This biological opinion is based on the assumption that salamanders at upper Garden Canyon Pond are Sonora tiger salamanders and that other populations east of the Huachuca Mountains on Fort Huachuca are *A. t. mavortium*. If this is not the case, the findings herein, including our conclusion, reasonable and prudent measures, and terms and conditions will need to be reassessed.

Tiger salamanders suspected of being Sonora tiger salamanders occurred in recent years at the lower Peterson Ranch tank in Scotia Canyon, which is within approximately one mile of Gate No. 7 and upper Garden Canyon Pond. The upper reaches of Scotia Canyon supports perennial surface water and the canyon may be a movement corridor for salamanders to access higher elevation sites in the Huachuca Mountains from localities in and near the lower reaches of Scotia and Sunnyside canyons. Salamanders have not been observed at the lower Peterson Ranch tank in the last few years; this population may be extirpated.

Threats to Sonora tiger salamander in the project area include erosion, sedimentation, and smoke or ash toxicity due to wildfire, prescribed fire, or managed natural fire, and suppression activities; death or injury of salamanders due to off-road vehicles illegally driving through upper Garden Canyon Pond; illegal collection of salamanders for bait or other purposes; introduction of nonnative fish, bullfrogs, or other subspecies of salamanders to Sonora tiger salamander habitat that may prey upon or spread disease to Sonora tiger salamanders; and in the case of other subspecies, interbreed with and cause genetic swamping of the Sonora tiger salamander population. Crayfish are present in upper Garden Canyon Pond and likely prey on salamander larvae and eggs, but such predation has not been documented.

The upper Garden Canyon Pond nearly went dry in the spring of 1996, at which time only one aquatic salamander was apparently present (SAIC 1998a). The pond dried again in June 1997 (J. Collins pers. comm. 1998) and June 1999 (J. Rorabaugh, Fish and Wildlife Service, pers. obs. 1999). Periodic drying results in the elimination or metamorphosis of aquatic larval and branchiate salamanders. Reduced water levels stimulates metamorphosis, and many salamanders simply walk away from drying ponds and return to breed when the pond refills. However, if the pond remained dry for several seasons or for years, or water was not present long enough to allow breeding and metamorphosis, the number of surviving terrestrial salamanders might not be sufficient to recolonize the pond. Recolonization would then have to occur as a result of immigration from another pond. If the population at lower Peterson Ranch tank is extirpated, no known salamander populations are nearby (closer than three or four miles) from which immigrants could be expected. Thus, once extirpated from the upper Garden Canyon Pond, natural recolonization might not occur, or might take a very long time. Vehicle travel through Gate No. 7 and into Scotia Canyon has caused localized areas of erosion in the upper parts of Scotia Canyon that may have contributed to a head cut that threatens to breach the lower Peterson Ranch tank. However, the Fort recently closed gate No. 7, removed the cattle guard, and placed boulders and fencing at the gate to prevent vehicular travel between Garden and Scotia canyons.

The Fort recently contracted with Dr. James Collins at Arizona State University to prepare a conservation plan for the Sonora tiger salamander at Fort Huachuca. This plan was in draft form as of this writing. It will provide management recommendations for conserving populations of the Sonora tiger salamander at Fort Huachuca.

EFFECTS OF THE PROPOSED ACTION

The only direct or indirect effects of the proposed action that have much potential to adversely affect the Sonora tiger salamander are effects of wildfire ignited by authorized activities, such as ordnance delivery, careless recreationists, catalytic converters, and other human-caused sources; prescribed fire and managed natural fire; and fire suppression activities.

We are not aware of any studies that evaluated the effects of fire on salamanders. However, fire could potentially result in direct death or injury of salamanders, and reduced habitat quality or quantity. Degradation of watershed condition immediately after fires results in dramatically increased runoff, sedimentation, and debris flow that can scour aquatic habitats in canyon bottoms or bury them in debris (DeBano and Neary 1996). In degraded watersheds, less precipitation is captured and stored, thus perennial aquatic systems downstream may become ephemeral during dry seasons or drought (Rinne and Neary 1996). Fire, whether

ignited by a natural or human-caused source, could result in degradation of the immediate watershed around a pond, and result in erosion, sedimentation, and ash flow into the pond. Although effects on salamanders are unknown, in salmonid fish, ash and slurry flow into streams can be toxic and populations of macroinvertebrates (salamander prey species) can be drastically reduced after a fire (Rinne 1996), at least temporarily (Roby and Azuma 1995). Smoke diffusion into water and ash flow can result in high level of phosphorus and nitrogen (Spencer and Hauer 1991) with unknown effects to salamanders. James Petranksa (University of North Carolina at Asheville, pers. comm. 1998) notes that fire can be detrimental to plethodontid salamanders by eliminating ground cover and associated invertebrates that are key food sources. Mike Lanoo (Indiana University School of Medicine, Muncie, pers. comm. 1998) has never observed any direct effects to tiger salamanders as a result of summer fires in Indiana prairies, but he has noted reduced invertebrate populations in high sediment habitats that resulted in lower food availability for salamanders. In this case, a red-leg (a bacterial infection) outbreak occurred. Dr. Lanoo suspected that ash flow into a pond could cause the same result.

Siltation of a pond due to erosion and runoff following a fire could eliminate habitat. However, the effects of siltation may also be more subtle. Lefcort *et al.* (1997) examined the effects of silt on growth and metamorphosis of larval mole salamanders, *Ambystoma opacum* and *A. tigrinum tigrinum*. Salamanders in silty water grew more slowly, metamorphosed sooner, and were more susceptible to infection by a water mold, *Saprolegnia parasitica*, than salamanders in non-silty water.

Fire effects could occur on or off of Fort Huachuca. A wildfire or prescribed or managed natural fire that escapes prescription could potentially burn onto Coronado National Forest land west of the Fort and affect salamander populations and habitat on the west slope of the Huachuca Mountains and adjacent areas of the San Rafael Valley. The chances of a large regional fire resulting from an ignition at Fort Huachuca during the life of the project is probably low, but high fuel loads in portions of the Huachuca Mountains on post (Danzer *et al.* 1997) and recent large stand-replacing fires in the Huachuca Mountains to the south of Fort Huachuca (Carr Peak fire in 1977, Pat Scott Peak fire in 1983) suggest that such a fire is possible. General Wildlife Services (undated) suggest that the Garden Canyon area "is perhaps primed for a catastrophic fire that could lead to major erosion and debris flow on the mid-elevations of the watershed and possible flooding and channel scouring in the lower drainage." The Fort has committed to implementing prescribed fire and/or fuels management as soon as possible to reduce the fire risk (Appendix 1).

Upper Garden Canyon Pond is the most important habitat for the salamander at Fort Huachuca, because it is where breeding and larval development occurs. Little is known about where adult terrestrial Sonora tiger salamanders go when not at the breeding ponds. Unlike some salamanders, terrestrial Sonora tiger salamanders are virtually never encountered on the

surface, except at or in the immediate vicinity of breeding ponds. However, a Sonora tiger salamander was captured in a pit fall trap at Oak Spring in Copper Canyon, Huachuca Mountains, by Arizona Game and Fish Department personnel. The nearest known breeding site is approximately 0.6 mile to the south, suggesting the salamander may have moved at least that far. Capture in a pit fall trap also confirms that the individual was surface active. In other subspecies of *Ambystoma tigrinum*, metamorphs may disperse hundreds of meters from the breeding pond, or may remain nearby (Petranka 1998, Gelbach *et al.* 1969). Of hundreds of marked *Ambystoma tigrinum nebulosum*, two were found to move from 0.9-1.2 miles to new ponds (J. Collins, pers. comm. 1998). On Fort Huachuca, Sheridan Stone (pers. comm. 1998) reports finding terrestrial tiger salamanders (probably *A. t. mavortium*) 1.9-2.5 miles from the nearest known breeding pond. Referring to conservation of the California tiger salamander, *A. californiense*, Petranka (1998) finds that based on studies of movements of other *Ambystoma* species, conservation of a 650-1,650 foot radius of natural vegetation around a breeding pond would protect the habitat of most of the adult terrestrial population.

Adults of western subspecies of *A. tigrinum* typically live in or about mammal burrows (Petranka 1998), although metamorphs may construct their own burrows, as well (Gruberg and Stirling 1972, Semlitsch 1983). Some species of salamanders exhibit seasonal migrations of up to several miles each way from breeding sites to upland habitats (Stebbins and Cohen 1995). If such migrations occur in the Sonora tiger salamander, we have no information about migration corridors or non-breeding habitat. Because of the arid nature of the environments in this region, if salamanders move very far from breeding ponds, they may use wet canyon bottoms, such as Scotia and Garden canyons, as movement corridors.

Probably the greatest threat to non-breeding terrestrial salamanders is fire. Erosion and increased runoff could bury or flood burrows, burrow entrances, rock shelters, or other cover sites. Fire may also reduce surface cover such as logs and debris, resulting in reduced invertebrate populations and reduced prey densities for salamanders (James Petranka, University of North Carolina, Asheville, pers. comm. 1998). Reduced cover may also result in heating and dessication of moist cover sites that salamanders require.

Fire suppression activities could also affect salamanders or their habitat. Most importantly, during fire suppression helicopters are sometimes used to scoop water from ponds or lakes and then drop that water on the fire. Ponds that are depleted from such operations are often refilled from a nearby large lake or reservoir. Because of the location of upper Garden Canyon Pond at Fort Huachuca and its small size, it is unlikely that a helicopter would attempt to take water from it for fire suppression. However, if that was done, aquatic salamanders could be scooped out of the pond and dropped on the fire. If the pond was refilled from Parker Canyon Lake or one of the impoundments on the Fort, nonnative predaceous fish, bullfrog tadpoles, or *Ambystoma tigrinum mavortium* could be introduced into the pond with deleterious effects described above in the Status of the Species. Introduction of *A. t. mavortium* into the range of

A. t. stebbinsi could be particularly damaging, and once introduced it could spread to other ponds. If fish were introduced into the upper Garden Canyon Pond, they likely would not survive for a long period, because the pond dries periodically.

Collection, transport, or release of salamanders or live fish; and driving off-road through ponds is illegal at Fort Huachuca. However, an employee of the Fort recently admitted to collecting and selling tiger salamanders (probably *Ambystoma tigrinum mavortium*) from ponds on the bajada at Fort Huachuca east of the Huachuca Mountains (Jon Snyder, Arizona State University, Tempe, pers. comm. 1998). Effects of collection, sale, and use of salamanders by anglers, and effects of other such illegal activities are considered interrelated and interdependent to the Fort's activities. Driving through upper Garden Canyon Pond and introduction or collection of salamanders and other organisms by the public or employees could not occur but for jobs provided by the Fort, and public access authorized by the Fort and provided for by roads maintained by the Fort. The Fort proposed placing barriers around the pond to prevent vehicles from accessing the pond. This work was recently completed. The pond would also be signed as closed to off-road vehicle use, fishing, and capture or release of salamanders.

There are 16 ponds (approximately 32 acres) located on post. Seven of these ponds are stocked with trout if water conditions are favorable (Figure 5), and some ponds are known to contain bass, sunfish, and/or catfish. Golf Course and Gravel Pit ponds may be fished 24 hours per day, year round, with the proper permits. Most fishing occurs at Golf Course, Gravel Pit, Lakeside, and Woodcutter's ponds (J. Hessil, pers. comm. 1998). In Arizona, anglers commonly move fish among aquatic sites, either to create new fishing opportunities, or by use of bait fish. As discussed, introduction of sunfish, bass, mosquito fish, or catfish could result in elimination of aquatic salamanders from upper Garden Canyon Pond.

Tiger salamanders are commonly moved among sites by anglers and bait collectors. Illegal transport and introductions of salamanders in the San Rafael Valley were documented by Collins and Jones (1987), and as noted above, illegal collection and sale of salamanders has occurred at Fort Huachuca. Salamanders could be collected from upper Garden Canyon Pond by bait collectors. The relatively clear water in the pond facilitates detection and collection. If salamanders were transported to the upper Garden Canyon Pond from ponds elsewhere at Fort Huachuca or from other locales east of the Huachuca Mountains, these salamanders would likely be *Ambystoma tigrinum mavortium*; which could genetically swamp *A. t. stebbinsi* at upper Garden Canyon Pond and could potentially move down Scotia Canyon to other salamander localities. Transport of salamanders among ponds could also spread the iridovirus that regularly decimates populations in the San Rafael Valley. Sheridan Stone (pers. comm. 1998) recorded a die off of tiger salamanders at one of the ponds at Fort's wastewater treatment plant. The iridovirus is a likely cause. The disease could also be spread by anglers

via waders, tackle or other equipment used at a pond where the disease is present and then using that same wet or muddy equipment at upper Garden Canyon Pond.

The following factors suggest that the likelihood of collection of salamanders, intentional or unintentional stocking of fish or salamanders at upper Garden Canyon Pond, and that spread of disease to the pond by anglers, is probably low during the life of the project: 1) transport and release of live salamanders and fish are illegal at Fort Huachuca, thus these activities probably occur infrequently, 2) fisherman are required to obtain a Fort Huachuca fishing permit and permitted individuals are given a fact sheet that clearly states live fish may not be transported or used as bait on Fort Huachuca (the fact sheet will be amended by September 30, 1999, to say that capture, transport, or release of live salamanders is strictly prohibited - Appendix 1), and 3) the upper Garden Canyon Pond is far removed from stocked ponds and tanks, which are on the bajada. If fish were illegally introduced to upper Garden Canyon Pond, periodic drying of the pond would eliminate them, but perhaps not before the fish had eliminated the aquatic salamanders.

Cumulative Effects

Cumulative effects are those adverse effects of future non-Federal (State, local government, and private) actions that are reasonably certain to occur in the project area. Future Federal actions would be subject to the consultation requirements established in section 7 of the Act and, therefore, are not considered cumulative to the proposed project. Effects of past Federal and private actions are considered in the Environmental Baseline. Much of the land in the project area is managed by Federal agencies, particularly the Coronado National Forest, Fort Huachuca, and Coronado National Memorial. However, several of the known occupied breeding localities are located on private lands to the west of Fort Huachuca, and others are likely to occur on private lands because only the Federal lands have been surveyed extensively. These private lands are used primarily for grazing, but potentially could be subdivided and developed as ranchettes, or used for other purposes. Compliance with the Act for activities on private lands that may affect the Sonora tiger salamander, but are not addressed by section 7 consultation, could occur through section 10(a)(1)(B) of the Act.

Effectiveness of Proposed Mitigation

The Fort has proposed substantial measures to mitigate the effects of the action on the salamander. These measures are found in the "Proposed Mitigation Measures" in the "Description of the Proposed Action" herein, and in the species-specific measures and general mitigation measures in Appendix B of the MOA (Appendix 1 herein). Most of the proposed mitigation measures were originally recommended by the Service to the Fort, and were subsequently adopted by the Fort as part of the proposed action. These measures can be

summarized as follows: (1) environmental awareness training, (2) mutual aid agreements with the Coronado National Forest and local governments to assist with fire suppression, (3) development of a species-specific management plan for the salamander, (4) establish a schedule to implement as soon as possible prescribed burns and/or fuels management to reduce fuel loading in the Huachuca Mountains, (5) construct a barrier to vehicles at upper Garden Pond (completed), (6) closure of Gate No. 7 (completed), (7) amendment of the Fort's "Fishing Facts" to provide further protection of the salamander, (8) posting fishing and vehicle regulations at upper Garden Pond, and (9) measures to reduce effects of fire management activities on the salamander and its habitat. These measures are expected to be effective at mitigating most of the effects of the action on the salamander and its habitat.

CONCLUSION

After reviewing the current status of the Sonora tiger salamander, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Sonora tiger salamander. No critical habitat is designated for this species, thus none will be affected. Our conclusion of "no jeopardy" is based on the following:

1. Only one of approximately 50 salamander breeding sites is located at Fort Huachuca.
2. The Fort prohibits vehicle use off of roads, transport and release of live fish and salamanders, and has proposed other mitigating measures that reduce the threats to the Sonora tiger salamander.
3. The threat of wildfire is expected to be reduced through a comprehensive fire management plan that calls for prescribed fire and reduction of fuel loads. Implementation of the plan will help reduce the chance of catastrophic stand-replacing fire that could adversely affect salamander habitat on and off-post.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential

behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Harass is defined in the same regulation by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take of a listed animal species that is incidental to, and not the purpose of, the carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of sections 7(b)(4) and 7(o)(2) of the Act, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by Fort Huachuca so that they become binding conditions of any grant or permit issued to any applicant, permittee, or contractor, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Fort has a continuing duty to regulate the activity covered by this incidental take statement. If the Fort (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant, permittee, or contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Fort Huachuca must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

Take of Sonora tiger salamander could occur in the form of harm, harassment, injury, or death resulting from 1) escaped prescribed fire or managed natural fire, 2) decisions made during fire suppression, 3) illegal recreational off-road vehicle use at upper Garden Canyon Pond, and 4) illegal transport and release of predaceous fish and/or *Ambystoma tigrinum mavortium* at upper Garden Canyon Pond, or capture of Sonora tiger salamanders. The Service anticipates loss of the entire aquatic population of Sonora tiger salamanders at upper Garden Canyon Pond once during the life of the project due to causes 1, 2, or 4, above. The Service anticipates take due to harassment, harm, injury, or death of up to 10 Sonora tiger salamanders due to cause 3 during the life of the project.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. This biological opinion does not authorize any form of take not incidental to implementation of the proposed action as described in this opinion and in SAIC (1998a). Note that this opinion anticipates but does not authorize take of Sonora tiger salamander due to

illegal activities such as illegal transport and release of fish or salamanders, capture of Sonora tiger salamanders, and off-road vehicle activity.

EFFECT OF THE TAKE

The Service has determined that the level of anticipated take is not likely to jeopardize the continued existence of the Sonora tiger salamander. If the entire aquatic population at upper Garden Canyon Pond was lost due to the above causes, the pond would likely be recolonized as terrestrial salamanders returned to the pond to breed. The likelihood of the aquatic population being eliminated is greatly reduced by the reasonable and prudent measure and term and condition.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measure is necessary and appropriate to minimize impacts of incidental take of Sonora tiger salamander:

Prompt implementation of proposed mitigation measures.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Fort must comply with the following term and condition in regard to the proposed action. This term and condition implements the reasonable and prudent measures described above. Terms and conditions are nondiscretionary. Genetic testing of the salamanders at upper Garden Canyon Pond is incomplete. If subsequent information suggests salamanders at upper Garden Canyon pond are not of the subspecies *stebbinsi*, then this term and condition is not needed and reinitiation of consultation would be warranted.

The following term and condition implements the reasonable and prudent measure:

The Fort shall promptly implement measures 2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 15, 16, 17 of the "Proposed Mitigation Measures" in the "Description of the Proposed Action" herein, and mitigation measures specific to the Sonora tiger salamander, as well as general mitigation measures and reporting requirements in Appendix B of the MOA (Appendix 1 herein).

If the incidental take anticipated in the paragraph entitled "Amount or Extent of Take" is met, the Fort shall immediately notify the Service in writing. If, during the course of the action, the level of anticipated incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation. In the interim, the Fort must cease the activity resulting in the take if it is determined that the impact of additional taking will cause an irreversible and adverse impact on the species. Fort Huachuca must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures. in the preceding paragraph is met, the Fort shall immediately notify the Service in writing.

CONSERVATION RECOMMENDATIONS

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information on listed species. The recommendations provided here does not necessarily represent complete fulfillment of the agency's section 2(c) or 7(a)(1) responsibilities for the Sonora tiger salamander. In furtherance of the purposes of the Act, we recommend implementing the following actions:

- 1) The Fort should study the movements and habitat use of terrestrial salamanders in and near upper Garden Canyon pond.
- 2) The Fort should continue to actively participate in the preparation of the Sonora tiger salamander recovery plan.
- 3) If the Sonora tiger salamander is found breeding at sites other than upper Garden Canyon pond on Fort Huachuca, the Fort should, in accordance with 50 CFR 402.16(b), reinitiate this consultation, as the Service believes this would represent new information revealing that the effects of the action may affect the salamander in a manner or to an extent not considered herein.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitat, the Service requests notification of the implementation of any conservation recommendations.

(Note: surveys for Sonora tiger salamander that involve capture or take require appropriate permits from the Service and Arizona Game and Fish Department.)

DISPOSITION OF DEAD OR INJURED LISTED ANIMALS

Upon locating a dead or injured threatened or endangered animal, initial notification must be made to the Service's Division of Law Enforcement, Federal Building, Room 8, 26 North McDonald, Mesa, Arizona (602/261-6443) within three working days of its finding. Written notification must be made within five calendar days and include the date, time, and location of the animal, a photograph, and any other pertinent information. Care must be taken in handling injured animals to ensure effective treatment and care, and in handling dead specimens to preserve biological material in the best possible condition. If feasible, the remains of intact specimens of listed animal species shall be submitted to educational or research institutions holding appropriate State and Federal permits. If such institutions are not available, the information noted above shall be obtained and the carcass left in place.

Arrangements regarding proper disposition of potential museum specimens shall be made with the institution prior to implementation of the action. Injured animals should be transported to a qualified veterinarian by a qualified biologist. Should any treated listed animal survive, the Service should be contacted regarding the final disposition of the animal.

CONCURRENCES

The Service concurs with the Forts determinations of may affect, not likely to adversely affect for the spikedace, loachminnow, and Canelo Hills ladies'-tresses. The rationale for these concurrences is detailed in the following discussions by species.

Spikedace

STATUS OF THE SPECIES

The spikedace was listed as a threatened species on July 1, 1986 (Service 1986). Critical habitat was designated for spikedace on March 8, 1994, including Aravaipa Creek, portions of the Gila River in New Mexico, and the upper Verde River (Service 1994a); however, as recognized in a recent Federal Register notice (63 FR 14378), the critical habitat designation was set aside by court order in Catron County, New Mexico.

Spikedace are a small silvery fish whose common name alludes to the well-developed spine in the dorsal fin (Minckley 1973). Spikedace historically occurred throughout the mid-elevations of the Gila River drainage, but is currently known only from Aravaipa Creek (Graham and Pinal Counties, Arizona), the upper Gila River (Grant and Catron Counties, New Mexico), the middle Gila River (Pinal County, Arizona), Eagle Creek (Greenlee County, Arizona), and the Verde River (Yavapai County, Arizona) (Barber and Minckley 1966, Minckley 1973, Anderson 1978, Barrett *et al.* 1985, Bestgen 1985, Marsh *et al.* 1990, Sublette *et al.* 1990, Jakle 1992, Knowles 1994). Habitat destruction, and competition and predation from introduced nonnative fish species are the primary causes of the species decline (Miller 1961, Williams *et al.* 1985, Service 1986, Douglas *et al.* 1994).

Spikedace live in flowing water with slow to moderate water velocities over sand, gravel, and cobble substrate (Propst *et al.* 1986, Rinne and Kroeger 1988). Specific habitat for this species consists of shear zones where rapid flow borders slower flow, areas of sheet flow at the upper ends of mid-channel sand/gravel bars, and eddies at downstream riffle edges (Propst *et al.* 1986). Spikedace spawn from March through May with some yearly and geographic variation (Barber *et al.* 1970, Anderson 1978, Propst *et al.* 1986). Spawning has not been observed, but spawning behavior indicates eggs are laid over gravel and cobble where they adhere to the substrate. Spikedace live about two years with reproduction occurring primarily in one-year old fish (Barber *et al.* 1970, Anderson 1978, Propst *et al.* 1986). It feeds primarily on aquatic and terrestrial insects (Schreiber 1978, Barber and Minckley 1983, Marsh *et al.* 1989).

The effects of historic and present perturbations in the Gila River basin have resulted in fragmentation of spikedace range and isolation of remnant spikedace populations. Recent taxonomic and genetic work on spikedace indicate there are substantial differences in morphology and genetic makeup among remnant spikedace populations. Anderson and Hendrickson (1994) found that spikedace from Aravaipa Creek are morphologically distinguishable from spikedace from the Verde River, while spikedace from the upper Gila River and Eagle Creek populations have intermediate measurements and partially overlap the Aravaipa and Verde populations. Mitochondrial DNA and allozyme analyses have found similar patterns of geographic variation within the species (Tibbets 1992).

Although the spikedace is currently listed as threatened, the Service has found that it warrants uplisting to endangered status. Reclassification is pending; however, work on it is precluded due to work on other higher priority listing actions (Service 1994b). The need for reclassification is not due to data on declines in the species itself, but is based upon increases in serious threats to a large portion of its habitat.

ENVIRONMENTAL BASELINE

Spikedace are not currently known from Fort Huachuca or the upper San Pedro River basin (Sally Stefferud, Service, Phoenix, pers. comm. 1998); however, the species occurred in the upper San Pedro River historically (BLM 1998). Spikedace occur in Aravaipa Creek, a tributary to the lower San Pedro River, in suitable habitat throughout the area of perennial flow (Barber and Minckley 1966, Minckley 1973, Velasco 1994). For several years spikedace were thought to be extirpated in the San Pedro and middle Gila river (between Coolidge and Ashurst-Hayden Dams) systems with the exception of Aravaipa Creek. However in 1991, a single spikedace was collected in the Gila River near Florence (Jakle 1992), suggesting the species may occur elsewhere on the Gila and lower San Pedro rivers downstream of the Aravaipa confluence.

Aravaipa Creek is a tributary of the San Pedro River in Pinal and Graham counties, Arizona. It is a perennial stream of about 10 cfs base flow with a median flow of 16 cfs (Minckley 1981). Aravaipa Creek is a flashy stream with flood flows occurring during summer and winter storms. The two-year flood event is estimated at 3,790 cfs and the 50-year event at 22,100 cfs [U.S. Federal Emergency Management Agency (USFEMA) 1994]. The January-February 1993 flooding peaked at an estimated 13,000 cfs (USFEMA 1994).

The Aravaipa Creek watershed is large, encompassing about 537 square miles [US Geological Survey (USGS) 1993]. Perennial flow is currently confined to a segment of about 15 to 20 miles within Aravaipa Canyon, although in the past five years the creek has often flowed all the way to the San Pedro River.

Aravaipa Creek supports a relatively intact native fish community and few nonnative fish, a rare situation in the Gila River basin (Barber and Minckley 1966, Minckley 1981, Velasco 1994). All native fish species in Aravaipa Creek are either federally listed or species of concern, including roundtail chub, *Gila robusta*; longfin dace, *Agosia chrysogaster*; speckled dace, *Rhinichthys osculus*; desert sucker, *Catostomus [Pantosteus] clarki*; Sonora sucker, *Catostomus insignis*; spikedace, and loach minnow. Nonnative species recorded include yellow bullhead, *Ameiurus natalis*; black bullhead, *Ameiurus melas*; green sunfish, *Lepomis cyanellus*; mosquitofish, *Gambusia affinis*; carp, *Cyprinus carpio*; and fathead minnow, *Pimephales promelas*. Red shiner, *Cyprinella lutrensis*, have been found in Aravaipa Creek, but have not yet become established (Velasco 1994). Largemouth bass, *Micropterus salmoides*, are also occasionally found in the creek.

Aravaipa Creek is a moderate velocity stream with a relatively low gradient (less than one percent). The substrate is primarily gravel-cobble with some bedrock in the canyon center and increasing amounts of sand and fine sediment below the canyon. Habitat is predominantly

riffles and runs with pools being formed by bedrock, canyon walls, and large woody material (Barber and Minckley 1966, Minckley 1981, Rinne 1985, Velasco 1994). The canyon bottom is narrow and side slopes are steep (30 to 60 degrees) (FEMA 1994). Most floodplain terraces have been irrigated and farmed over the past 100 years. In the project area, most of the non-wilderness valley bottom is privately owned. The largest of the private parcels belongs to The Nature Conservancy, which holds the land as a nature preserve. The remaining parcels are mainly private residences, although many are second or weekend homes. Agricultural operations are occurring on several of the parcels.

In Aravaipa Creek there are a number of threats to the spikedace and its habitat. Aravaipa Creek and its watershed have been subjected to substantial human uses since the settlement of the area by Europeans. The watershed, like many in the desert southwest, has been altered by grazing, mining, timber harvest, water development, irrigated agriculture, roads, recreation, and other human uses (Minckley 1981, Bahre 1991). These uses have altered runoff, sediment transport, and groundwater recharge patterns within the basin and may have caused changes in the perennial flow of Aravaipa Creek. Minckley (1981) reports that comparisons of recent and 80 to 120 year-old accounts and photographs reveal that the dry incised stream channel near Klondyke was historically a marshy area of perennial water. He also reports that riparian forests were more massive in size and development with a larger component of younger trees, and that common reed, *Phragmites australis*, first noted by Bell in 1869 (as cited in Minckley 1981), has been eliminated from Aravaipa Creek.

Aravaipa Creek has not been perennial to the confluence with the San Pedro River within historic times (Hutton 1859 as cited in Davis 1986). However, the average perennial length and duration has decreased, within a range of substantial yearly variation. Hutton recorded extensive cottonwood, sycamore, and ash along the lower five miles of the stream that he believed to be intermittent. That riparian forest has mostly disappeared, indicating a likely decrease in duration or amount of surface or subsurface flow. With the loss of the cienega below Klondyke, the perennial length of Aravaipa Creek decreased, a trend which continued with the introduction of groundwater pumping into the Aravaipa watershed. Adar (1985) estimates the present usual beginning of perennial flow to be about two miles downstream from its 1900 location.

Human uses along Aravaipa Creek have resulted in alterations to the stream channel. Diversion dams have been, and continue to be, constructed in several places to channel water into irrigation ditches. These generally consist of using heavy equipment to push up an earth and rock berm which impounds small areas but washes out in high water. Channelization has taken place along many segments of the stream. Riprap, earthen dikes, and other forms of channel control have been constructed. Although none of these is a major channel modification, their effects are cumulative. Constraining a stream channel may cause upstream and downstream channel modifications, and erosion and failure of such structures often causes

radiating erosion (Rosgen 1994). Minckley (1981) notes that in photographs from prior to 1900, streambanks along the east end of the perennial flow were less incised than at present.

In the late 1800's and early 1900's mining was occurring at various locations in the Aravaipa watershed. A lead mill was built at Klondyke in 1925 and the tailings from that mill are located on the bank of Aravaipa Creek. Recent changes in the stream channel are resulting in erosion of the tailings into the creek. Surface and groundwater violations of water quality have been documented in the area of the tailings (Hyde 1993).

Although Aravaipa Creek presently supports fewer nonnative species than many of Arizona's streams, the number and distribution of nonnative species is increasing. In 1981, four nonnative fishes were known from the watershed and only two of those were recorded from Aravaipa Creek itself (Minckley 1981). By 1992, eight nonnative fishes were known from Aravaipa Creek and at least four of those were thought to be reproducing in the creek (Velasco 1994). The remaining four were thought to originate from movement out of ponds, stock tanks, and the San Pedro River. Green sunfish, largemouth bass, and yellow and black bullhead are all predatory species that consume spinedace. Red shiner is thought to be highly detrimental to small native cyprinids, such as spinedace through competition and/or predation (Bestgen 1986; Marsh *et al.* 1989; Rinne 1991). Although red shiner invaded the entire perennial length of Aravaipa Creek in 1990-91, they did not establish a population and have only been found once since, in lower Aravaipa Creek in October 1993 (Bettaso 1993).

BLM lands in Aravaipa Creek were withdrawn from grazing in 1974 with the exception of the Brandenburg Mountain allotment, which contains only approximately 0.1 mi of Aravaipa Creek and an additional 0.1 mi reach of Aravaipa Creek in the Quintana allotment. However, pursuant to the recent biological opinion, cattle will be removed from these reaches, as well. Reaches of Aravaipa Creek in private ownership have also been fenced through Service Partners for Wildlife Projects. Removal of grazing from most lands in Aravaipa Creek has resulted in improved riparian/aquatic habitat conditions (BLM 1996). Improvements in riparian/aquatic habitat conditions have occurred through the combined efforts of the permittees, the BLM, and other concerned parties and agencies.

In the 19th century the lower San Pedro River was marshy with beaver ponds but was incised in some reaches (Etz 1938, Hendrickson and Minckley 1984). Reports vary as to whether the river was perennial throughout its length; but some authors reported ephemeral flows downstream of Tres Alamos in the lower San Pedro. Perennial waters in the lower basin persist today at Bingham Swamp near Redington, a reach approximately 6.5 mi downstream of Redington, and at Cook's Lake near the Aravaipa confluence.

Jakle (1995a&b) sampled fish from 1991 through 1994 along reaches of the Gila River downstream of the San Pedro confluence and on the San Pedro River from Dudleyville to Lewis Springs. Sampling stations on the Gila River included seven sites from just below Coolidge Dam to the Ashurst-Hayden Diversion Dam. Six stations were sampled on the San Pedro River including the Dudleyville Crossing, Aravaipa confluence, San Manuel Crossing, Hughes Ranch near Cascabel, near Charleston, and near Lewis Springs. Thirteen species and a hybrid sunfish were collected on the Gila River. Native species included longfin dace, Sonora sucker, desert sucker, and a single spikedace collected at Cochran Crossing. On the San Pedro River, 11 species were collected, including two native species: longfin dace and desert sucker. No spikedace were collected on the San Pedro River. Numbers and distribution of desert suckers and longfin dace on the San Pedro and Gila rivers, and Sonora sucker on the Gila River increased markedly following high flows in 1993. Cumulative absolute abundance of nonnative fish did not change after high flows, although mosquitofish were greatly reduced in the Gila River and were not found at sampling stations on the San Pedro after the high flows.

When spikedace populations are at low levels, they can be very difficult to locate. Fish sampling data from the lower San Pedro and middle Gila rivers is limited and localized. Perennial flows in the Gila River, perennial and ephemeral flows that connect reaches of the San Pedro River with the Gila River and Aravaipa Creek, and the spikedace record at Cochran Crossing suggest that a small number of spikedace may be present on the lower San Pedro River from the Aravaipa confluence to Dudleyville, and possibly downstream on the middle Gila River. Based on findings for other native fish in these reaches, numbers of spikedace may increase temporarily in this area following flood events.

Although the species is currently thought to be extirpated, the upper San Pedro River is considered important recovery habitat for the spikedace. A number of agencies have been working towards native fish recovery in the San Pedro River. The BLM's management plan for the RNCA calls for "reintroduction of native wildlife species, including threatened and endangered species, as well as for consideration of "removal of exotic fish from existing ponds" (BLM 1989). BLM's habitat management plan for the area contains specific objectives for reintroducing spikedace. Funding is available through the Bureau of Reclamation as a result of the Central Arizona Project jeopardy biological opinion to remove nonnative fish from Kingfisher or Young-Block ponds near the Highway 90 crossing, as well as other measures needed to reduce nonnatives and reintroduce native fishes into the RNCA.

A recent biological opinion addressed BLM-authorized grazing activities in the Aravaipa and San Pedro rivers and their watersheds. Other formal consultations include non-jeopardy opinions issued in 1993 and 1994 for construction of riprap banks on Aravaipa Creek. In 1994, a biological opinion was issued finding jeopardy and adverse modification of critical habitat for spikedace (and loach minnow) from the potential for the Bureau of Reclamation's

Central Arizona Project to introduce and spread nonnative aquatic species. The reasonable and prudent alternative for removal of jeopardy included the construction on Aravaipa Creek of a paired set of barriers to upstream fish movement. This action is expected to substantially reduce future adverse impacts to spinedace and loach minnow through predation and competition by nonnatives. However, disruption of localized spinedace and loach minnow habitat is expected from construction and operation of the barriers. A February 15, 1995, non-jeopardy biological opinion on a proposed rerouting of a section of the Aravaipa road on the west end of the wilderness was superseded by a November 7, 1996, non-jeopardy biological opinion on a proposed bridge at that site.

EFFECTS OF THE PROPOSED ACTION

The Fort's proposed action does not include activities on Aravaipa Creek or at other spinedace localities, thus no direct effects would occur. However, as discussed in the Effects of the Proposed Action for the southwestern willow flycatcher, the upper and lower reaches of the San Pedro River are hydrologically connected, so that effects in the upper basin could potentially affect flows and riparian habitat in the lower basin. If groundwater pumping attributable to the Fort caused a reduction in flows on the lower San Pedro River, the spinedace could potentially be adversely affected. This possibility was examined in the Effects of the Proposed Action for the flycatcher. In that discussion, we concluded that groundwater pumping in the upper basin would not significantly affect flows in the lower basin for the following reasons: 1) flood flows are not affected by groundwater pumping, 2) the water budget prepared by ADWR (1991) estimates that no groundwater inflow occurs into the Benson subwatershed from the Sierra Vista subwatershed, and 3) groundwater inflow across subwatershed boundaries in the lower San Pedro River is also insignificant (ADWR 1991).

Groundwater flow between subwatersheds might be greater if water use did not exceed water supply in the Sierra Vista subwatershed, but because of the presence of cones of depression it is unlikely that any increased water supply would result in significant increases in subwatershed outflow. Even if the entire deficit (7,000 acre feet) was discharged as outflow from the subwatershed, this would only account for approximately 15 percent of the water supply in the Benson subwatershed. How much of this outflow might reach the river downstream of the Aravaipa confluence where spinedace are most likely to occur is unknown. The reach downstream of the Aravaipa confluence is in the Winkelman subwatershed immediately upstream of the Gila confluence. Annual water supply to the Winkelman subwatershed is 73,760 acre-feet, of which only 150 acre-feet is groundwater inflow from upstream (ADWR 1991). Although the effects of groundwater pumping in the Sierra Vista subwatershed on potential downstream spinedace habitat are uncertain, the best information available suggests that currently these effects are probably small or negligible. Effects of future groundwater pumping are predicted to be insignificant because baseflow into the subwatershed where spinedace may occur is very small.

As discussed for the Huachuca water umbel and the southwestern willow flycatcher, the indirect, interrelated, and interdependent effects of the proposed action combined with cumulative effects will cause dewatering of all or portions of the upper San Pedro River unless action is taken to balance water use with supply. This would eliminate important recovery habitat and opportunities for the spikedace. It is expected that implementation of water resources planning on-post and regionally (see Appendix 1) will mitigate effects to the river and preserve those recovery opportunities.

CONCLUSION

The Service concurs with the Fort's finding that the proposed action may affect, but is not likely to adversely affect the spikedace. We base this finding on the following:

- 1) The most important habitats and most significant population of spikedace in the San Pedro River watershed are in Aravaipa Creek, which would not be affected by groundwater pumping or other activities of Fort Huachuca.
- 2) With prompt development and implementation of groundwater management measures, as proposed by Fort Huachuca, groundwater pumping attributable to the proposed action is unlikely to have significant effects on flows in the lower San Pedro River.

Although the species does not currently occur in the San Pedro River, the proposed action threatens recovery habitat of the spikedace in the river. Thus, our concurrence assumes implementation of the water resource plans, both on-post and regionally (Appendix 1), which should remove threats to spikedace recovery habitat.

Loach Minnow

STATUS OF THE SPECIES

The loach minnow was listed as a threatened species on October 28, 1986. Critical habitat was designated for loach minnow on March 8, 1994, including portions of the San Francisco, Tularosa, Blue, and upper Gila rivers, and Aravaipa Creek. However, however, as recognized in a recent Federal Register notice (63 FR 14378), the critical habitat designation was set aside by court order in Catron County, New Mexico.

The loach minnow is a small, slender, elongate fish with markedly upwardly-directed eyes (Minckley 1973). Historic range of the loach minnow included the basins of the Verde, Salt, San Pedro, San Francisco, and Gila rivers (Minckley 1973, Sublette *et al.* 1990). Competition and predation by nonnative fish and habitat destruction have reduced the range of the species by about 85 percent (Miller 1961, Williams *et al.* 1985, Marsh *et al.* 1989). Loach minnow remains in limited portions of the upper Gila, San Francisco, Blue, Black, Tularosa, and White rivers; and Aravaipa, Eagle, Campbell Blue, and Dry Blue creeks in Arizona and New Mexico (Barber and Minckley 1966, Silvey and Thompson 1978, Propst *et al.* 1985, Propst *et al.* 1988, Marsh *et al.* 1990, Knowles 1995).

The loach minnow is a bottom-dwelling inhabitant of shallow, swift water over gravel, cobble, and rubble substrates (Rinne 1989, Propst and Bestgen 1991). The loach minnow uses the spaces between, and in the lee of, larger substrate for resting and spawning (Propst *et al.* 1988, Rinne 1989). It is rare or absent from habitats where fine sediments fill the interstitial spaces (Propst and Bestgen 1991). Some studies have indicated that the presence of filamentous algae may be an important component of loach minnow habitat (Barber and Minckley 1966). The life span of a loach minnow is about two years (Britt 1982, Propst and Bestgen 1991). Loach minnow feeds exclusively on aquatic insects (Schreiber 1978, Abarca 1987). Spawning occurs primarily in March through May (Britt 1982, Propst *et al.* 1988); however, under certain circumstances loach minnow also spawn in the autumn (Vives and Minckley 1990). The eggs of the loach minnow are attached to the underside of a rock that forms the roof of a small cavity in the substrate on the downstream side. Limited data indicate that the male loach minnow may guard the nest during incubation (Propst *et al.* 1988, Vives and Minckley 1990).

Recent biochemical genetic work on loach minnow indicate there are substantial differences in genetic makeup among remnant loach minnow populations. Remnant populations occupy reaches of the Gila basin that are isolated from each other. Tibbets (1992) recommended that the genetically distinctive units of loach minnow should be managed as separate units to preserve the existing genetic variation.

Although the loach minnow is currently listed as threatened, the Service has found that it warrants uplisting to endangered status. Reclassification is pending; however, work on it is precluded due to work on other higher priority listing actions (Service 1994b). The need for reclassification is not due to data on declines in the species itself, but is based upon increases in serious threats to a large portion of its habitat.

ENVIRONMENTAL BASELINE

Loach minnow are not currently known from Fort Huachuca or the upper San Pedro River basin (Sally Stefferud, pers. comm. 1998); however, the species occurred in the river

historically (BLM 1998). Within the San Pedro River watershed, the loach minnow is found in Aravaipa Creek and two tributaries to Aravaipa Creek: Deer Creek (Hell Hole) and Turkey Creek. In Aravaipa Creek, the loach minnow is presently found in suitable habitat throughout the area of perennial flow, which is a reach approximately 15 to 20 miles in length in Aravaipa Canyon (Barber and Minckley 1966, Minckley 1973, Velasco 1994). The population in Turkey Creek is small and limited to an area near the confluence (BLM 1996). The BLM (1996) considers the loach minnow population in Deer Creek to be large and self-sustaining.

Environmental baseline for Aravaipa Creek presented in the discussion for the spikedace is included here by reference. This baseline also applies to Turkey Creek and Deer Creek. Threats to spikedace in Aravaipa Creek and its watershed are also threats to the loach minnow and affect the loach minnow and its habitat in a similar fashion. As with the spikedace, the upper San Pedro River is considered important recovery habitat for the loach minnow.

EFFECTS OF THE PROPOSED ACTION

Effects of the proposed action on loach minnow are similar to those described for the spikedace, except that loach minnow is not currently suspected to occur in the lower San Pedro River. Thus, any possible effects would be to potential recovery habitat; and as described for the spikedace, the only significant effects would be in the upper San Pedro River. Under the most likely future scenario, continued groundwater pumping by Fort Huachuca and other water users in the Sierra Vista subwatershed in excess of supply will eventually lead to dewatering of all or portions of the upper San Pedro River and loss of recovery habitat (see Effects of the Proposed Action for the Huachuca water umbrella). It is expected that implementation of water resources planning on-post and regionally (see Appendix 1) will mitigate effects to the river and preserve those recovery opportunities.

CONCLUSION

The Service concurs with the Fort's determination that the proposed action may affect, but is not likely to adversely affect the loach minnow. We base this determination on the following:

The most important habitats and only populations of loach minnow in the San Pedro River watershed are in Aravaipa Creek, which would not be affected by groundwater pumping or other activities of Fort Huachuca.

Although the species does not currently occur in the upper San Pedro River, the proposed action threatens recovery habitat of the loach minnow in the river. Thus, our concurrence

assumes implementation of the water resources plan on-post and regionally (see Appendix 1) which, will mitigate effects to the river and preserve those recovery opportunities.

Canelo Hills Ladies' tresses

STATUS OF THE SPECIES

Canelo Hills ladies'-tresses is a slender, erect, terrestrial orchid that, when in flower, reaches approximately 20 inches tall. Five to ten, linear-lanceolate, grass-like leaves, 7.1 inches long and 0.6 inch wide, grow basally on the stem. The fleshy, swollen roots are approximately 0.2 inch in diameter. The top of the flower stalk contains up to 40 small, white flowers arranged in a spiral. The species is presumed to be perennial, but mature plants rarely flower in consecutive years and, in some years, have no visible aboveground structures (McClaran and Sundt 1992, Newman 1991). The species was listed as endangered in January 1997 (Service 1997a).

This species is known from five sites at about 5,000 feet elevation in the San Pedro River watershed in Santa Cruz and Cochise counties, southern Arizona (Newman 1991; Mima Falk, Coronado National Forest, pers. comm. 1996). The total amount of occupied habitat is less than 200 acres. Four of the populations are on private land less than 23 miles north of the U.S./Mexico border; one additional small site containing four individuals was discovered on public land in 1996 (Mima Falk, pers. comm. 1996). This site is located near a previously known population and may not be a distinct population. Potential habitat in Sonora, Mexico, has been surveyed but no *Spiranthes delitescens* populations have been found.

Estimating Canelo Hills ladies'-tresses population size and stability is difficult because non-flowering plants are very hard to find in the dense herbaceous vegetation, and yearly counts underestimate the population because dormant plants are not counted. McClaran and Sundt (1992) monitored marked individuals in a Canelo Hills ladies'-tresses population during two, three-year periods. They concluded that the subpopulations at both monitored sites were stable between 1987 and 1989, although Newman (1991) later reported that one monitored site was reduced to one non-flowering plant in 1991.

All populations of Canelo Hills ladies'-tresses occur in cienega habitats where scouring floods are very unlikely (Newman 1991). Soils supporting the populations are finely grained, highly organic, and seasonally or perennially saturated. Springs are the primary water source, but a creek near one locality contributes near-surface groundwater (McClaran and Sundt 1992).

The dominant vegetation associated with *Spiranthes* includes grasses, sedges, *Carex* spp.; rushes, *Juncus* spp.; spike rush, *Eleocharis* spp.; cattails, *Typha* spp.; and horsetails,

Equisetum spp. (Cross 1991, Warren *et al.* 1991). Associated grass species include bluegrass, *Poa pratensis*; Johnsongrass, *Sorghum halepense*; and muhlys, *Muhlenbergia aspeifolia* and *M. utilis* (Fishbein and Gori 1994). The surrounding vegetation is semi-desert grassland or oak savannah.

As with most terrestrial orchids, successful seedling establishment probably depends on the successful formation of endomycorrhizae (a symbiotic association between plant root tissue and fungi) (McClaran and Sundt 1992). The time needed for subterranean structures to produce aboveground growth is unknown. Plants may remain in a dormant, subterranean state or remain vegetative (non-flowering) for more than one consecutive year. Plants that flower one year can become dormant, vegetative, or reproductive the next year (McClaran and Sundt 1992, Newman 1991). The saprophytic/autotrophic state of orchid plants may be determined by climatic fluctuations and edaphic factors, such as pH, temperature and soil moisture (Sheviak 1990).

Threats to the Canelo Hills ladies'-tresses include groundwater pumping, water diversions, sand and gravel mining, recreation impacts, illegal collection, and invasion of cienega habitats by nonnative plant species, such as Johnsongrass and bermuda grass, *Cynodon dactylon* (Service 1997a). The nonnative Johnson grass is invading one *Spiranthes* site (Dave Gori, Arizona Nature Conservancy, in litt. 1993). This tall grass forms a dense monoculture, displacing less competitive native plants. If Johnsongrass continues to spread, the Canelo Hills ladies'-tresses population at this site may be lost (Dave Gori, in litt. 1993). The effect of livestock grazing on the Canelo Hills ladies'-tresses is unclear. A *Spiranthes* population growing at a site grazed for more than 100 years was found to be larger and more vigorous than a population growing at a site ungrazed since 1969 (McClaran and Sundt 1992, Newman 1991); however, this may no longer be the case as the management at the grazed site has changed dramatically in recent years. The Canelo Hills ladies'-tresses, like many species in the genus, shows an affinity for habitats with sparse herbaceous cover (McClaran and Sundt 1992); which moderate livestock grazing may promote. The species would likely be adversely affected by heavy livestock grazing; however, maintenance of viable populations is probably compatible with well-managed grazing. Mowing of pastures, particularly when the species is flowering, can be very detrimental, may prevent seed set, and could result in mortality of plants. Limited numbers of populations and individuals threatens this taxon with demographic and environmental extinction as a result of stochastic events that are often exacerbated by habitat disturbance. For instance, the restriction of the species to a relatively small area in southeastern Arizona increases the chance that a single environmental catastrophe, such as a severe tropical storm or drought could eliminate populations or cause extinction.

ENVIRONMENTAL BASELINE

Four of the five populations of Canelo Hills ladies'-tresses occur to the west of Fort Huachuca in the San Rafael Valley and Canelo Hills. The fifth population occurs at the Babocomari Cienega, located approximately 1.5 miles north of the northwest corner of Fort Huachuca. The environmental baseline is the same as the status of the species because all known populations occur near Fort Huachuca.

EFFECTS OF THE PROPOSED ACTION

The potential for groundwater pumping or fire ignited on the West Range to effect the Babocomari Cienega was evaluated in the Effects of the Proposed Action for the southwestern willow flycatcher. Although data is insufficient to make any conclusive statements, because the cienega is considerably upstream of wells at Fort Huachuca and the Sierra Vista wells, faulting and geology suggests much of the water in the area comes from the Mustang Mountains (Houser 1998), a geological feature forces groundwater to the surface at this site (ADWR 1991), and the river flows from the west, it is unlikely that groundwater pumping by Fort Huachuca or Sierra Vista currently affects or in the future would affect riparian or wetland habitat at or near the cienega. Chances of fire spreading from the northwestern boundary of the installation to the Babocomari Cienega is also unlikely due to the presence of Chihuahuan Desert scrub containing little fuel to carry fire between the installation boundary and the cienega. Figure 7 shows that areas near the northwestern boundary burned once or twice in the period 1973-1993. Fire breaks in training area J on the northwestern boundary also act to inhibit the spread of fire.

Off-post activities, such as ASA sites are not located adjacent to Canelo Hills ladies' tresses localities. UAVs or other aircraft could potentially crash at a locality, but the chances of this occurring during the life of the project are remote.

CONCLUSION

The Service concurs with the Fort's determination that the proposed action may affect, but is not likely to adversely affect the Canelo Hills ladies'-tresses. We base this determination on the following:

- 1) Although all five populations of Canelo Hills ladies'-tresses occur near Fort Huachuca, none occur on the Fort or in areas proposed for off-post activities.

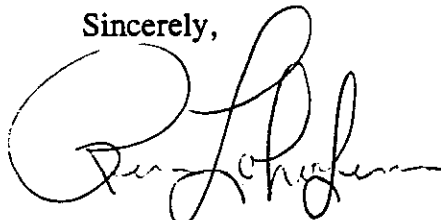
2) Available hydrological information suggests that groundwater pumping by Fort Huachuca are not likely to affect Canelo Hills ladies'-tresses habitat at Babocomari Cienega.

3) The probability of other activities of Fort Huachuca, such as fires ignited on the West Range or aircraft crashes adversely affecting the Canelo Hills ladies'-tresses is remote.

CLOSING STATEMENT

This concludes formal consultation on the Department of the Army's proposed land use, military operations, and training range utilization at and near Fort Huachuca, Arizona. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may adversely affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the agency action is subsequently modified in a manner that causes an effect to a listed species or critical habitat that was not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by this action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation, if it is determined that the impact of such taking will cause an irreversible and adverse impact to the species. Any questions or comments should be directed to Steve Chambers, Chief, Division of Threatened and Endangered Species, (505/248-6658); or Dave Harlow, Field Supervisor, Arizona Ecological Services Field Office (602/640-2720 ext. 244).

Sincerely,



Nancy M. Kaufman

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Regional Director

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District Chief, Water Resources Division, Arizona District, United States Geological Survey, Tucson, AZ

Area Manager, Bureau of Reclamation, Phoenix, AZ (attn: B. Ellis)

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Appendix 1: Memorandum of Agreement between the Service and the Fort amending the proposed action.

**MEMORANDUM OF AGREEMENT
BETWEEN
U.S. ARMY AND THE U.S. FISH AND WILDLIFE SERVICE**

**SUBJECT: WATER RESOURCES IN THE SIERRA VISTA SUBWATERSHED OF THE
UPPER SAN PEDRO RIVER BASIN**

1. Purpose. As of the date that this Memorandum of Agreement (MOA) is signed, the U. S. Army and the U.S. Fish and Wildlife Service (Service) are actively engaged in Section 7 formal consultation under the Endangered Species Act (ESA), consultation number 2-21-98-F-266, concerning the potential effects of ongoing and future operations at Fort Huachuca. The Army and the Service agree that water conservation and/or water augmentation may be required to address the potential impact of groundwater pumping on populations of Huachuca water umbel and southwestern willow flycatcher and critical habitat in the Sierra Vista Subwatershed of the Upper San Pedro River Basin (subwatershed). In order to mitigate the potential effects of groundwater pumping, the Army and Service agree to take an active role in water conservation and recharge efforts in the subwatershed, as outlined in this MOA.
2. Reference. This MOA is hereby made and entered into by and between the Army and the Service under the authority of the Endangered Species Act of 1973 (16 U.S.C. 1531-1543), as amended; the Fish and Wildlife Coordination Act (16 U.S.C. 661-667e), as amended; the Economy Act of 1932 (31 U.S.C. 1535); the Sikes Act of 1960 (16 U.S.C. 670a-670o), as amended; and other laws, as applicable.
3. Problem. A consensus of scientific opinion concludes that continued and projected aggregate pumping may impact portions of the San Pedro River and consequently, may threaten listed species and critical habitat. The Army and the Service recognize that current groundwater pumping in the subwatershed exceeds natural recharge, which creates a deficit situation. This issue is an important regional concern and cannot be addressed by the Army alone, or by any one party.
4. Scope. The Army and the Service are committed to conserving and recovering endangered and threatened species, conserving ecosystems and maintaining native biological diversity in the subwatershed. The subwatershed includes the San Pedro River National Conservation Area (SPRNCA), which includes critical habitat for the southwestern willow flycatcher and the Huachuca water umbel, two endangered species.

5. Understanding, agreements, support and resource needs.

a. General Obligations of the Army and Service. By entering into this MOA, the Service and the Army will:

(1) Support the Upper San Pedro Partnership (USPP) goals in sustaining base flows in the San Pedro River. The Service and the Army agree that the USPP is presently the best regional planning organization through which to address indirect, interrelated, and interdependent effects of the proposed action, as well as cumulative effects from all sources on listed species and critical habitat along the San Pedro River. The Army and the Service will encourage the USPP to appoint a regional water manager and to adopt as a goal maintenance of base flows in the San Pedro River sufficient to sustain species and habitat protected by the Endangered Species Act. To attain this goal may require acquiring and retiring water rights in the area, balancing water use with conservation and recharge projects, importing water, or any combination of these and other yet to be identified methods for attaining a balance between groundwater withdrawals and recharge sufficient to ensure continued baseflows.

(2) Develop and implement an Army Water Resources Management Plan (AWRMP), which the Army will seek to have incorporated into an USPP Plan. This MOA and its appendices are part of the Army's proposed action and will be incorporated as an appendix to the Biological Opinion issued by the Service.

(3) Work towards recovery of the Huachuca water umbel and southwestern willow flycatcher and their habitats within the subwatershed.

(4) Develop and implement measures and projects concerning all species addressed in the Biological Assessment (BA) and Biological Opinion (BO). For easy reference, the measures and projects concerning all species addressed in the BA and BO are listed in Appendix B.

(5) "... conserve (A) fish or wildlife which are listed as endangered species or threatened species ... or (B) plants ... (C) the ecosystems upon which endangered species and threatened species depend ..." (Endangered Species Act of 1973, 16 U.S.C. 1534);

(6) Allow the Secretary of Interior to "... administer (ESA) directly or in accordance with cooperative agreements ... and in accordance with such rules and regulations for the conservation, maintenance, and management of wildlife, resources thereof, and its habitat thereon ..." (Fish and Wildlife Coordination Act, 16 U.S.C. 664);

(7) Meet jointly as needed for any federal action that may affect endangered, threatened or proposed species or their habitats. These meetings will constitute informal consultation between the Service and the Army.

(8) Fully fund all obligations of the Service and the Army arising under this MOA. Both

parties agree to seek sufficient funding to fulfill their obligations under the MOA; however, any requirement for the payment or obligation of funds by either party established by the terms of the MOA will be subject to the availability of funds, and no provision herein will be interpreted to require obligation or payment of funds in violation of the Antideficiency Act, 31 U.S.C. section 1341. In cases where payment or obligation of funds would constitute a violation of the Antideficiency Act, the dates established requiring the payment or obligation of such funds will be appropriately adjusted.

(9) Develop an annual work plan to identify actions for implementation to fulfill the purposes of this MOA. This annual work plan will be developed jointly by the Army and the Service within two months of Fort Huachuca receiving its annual environmental operating budget allocation for each fiscal year.

b. Specific Obligations of the U.S. Fish and Wildlife Service. The Service will:

(1) Provide information on habitat quality and sensitivity for listed species for the development of Army endangered species management plans.

(2) Annually review the AWRMP with the Army. This includes project status and associated changes in water consumption.

(3) As appropriate for the purposes of this MOA, conduct, assist, and/or support surveys, censuses, and population monitoring of endangered and threatened species, proposed and candidate species, and other rare native species in coordination with the Army.

(4) As appropriate for the purposes of this MOA, conduct, assist, and/or support surveys and censuses of the distribution and condition of the habitats for endangered and threatened species, proposed and candidate species, and other rare native species in coordination with the Army.

(5) As appropriate for the purposes of this MOA, conduct, assist, and/or support research on the ecology and limiting factors of endangered and threatened species, proposed and candidate species, and other rare native species in coordination with the Army.

(6) Explore appropriate means to participate in the USPP and to fund projects.

(7) Join the Army in promoting the successful implementation of water conservation and recharge projects, thereby, encouraging the public and other federal, state, and local agencies to join in efforts associated with sustaining the San Pedro River and working toward recovery of listed species.

(8) The Service will fully consider the views of the Army, as appropriate, in carrying out the consultation process under Section 7 of the Endangered Species Act.

c. Specific Obligations of the U.S. Army. The Army will:

- (1) Develop and begin implementation of an AWRMP within three years (Appendix A).
- (2) Continue to implement water management projects.
- (3) Review the AWRMP with the Service within two months of Fort Huachuca receiving its annual environmental operating budget allocation for each fiscal year. This includes project status and associated changes in water consumption. The Army will provide a synopsis of the annual review meeting for approval by both parties.
- (4) As appropriate for the purposes of this MOA, conduct, assist, and/or support surveys, censuses, and population monitoring of endangered and threatened species, proposed and candidate species, and other rare native species in coordination with the Service.
- (5) As appropriate for the purposes of this MOA, conduct, assist, and/or support surveys and censuses of the distribution and condition of the habitats for endangered and threatened species, proposed and candidate species, and other rare native species in coordination with the Service.
- (6) As appropriate for the purposes of this MOA, conduct, assist, and/or support research on the ecology and limiting factors of endangered and threatened species, proposed and candidate species, and other rare native species in coordination with the Service.
- (7) Provide access to the employees of the Service who require access to Army lands on a regular basis for purposes related to this MOA. The Army may temporarily suspend access to certain areas for emergency or national defense purposes or for situations/purposes declared necessary by the Commander, U.S. Army Intelligence Center and Fort Huachuca.
- (8) Participate in the USPP and implement projects. The Army will actively participate in the Upper San Pedro Partnership (USPP), which includes assisting the development of an USPP Regional Water Resources Management Plan (USPP Plan) and supporting hydrologic research in the subwatershed.
- (9) Assign a senior level person to oversee implementation of this MOA and commit appropriate resources, as necessary, to support the purposes of the MOA.
- (10) Keep the public informed of projects implemented to conserve water and increase recharge, and will periodically solicit public input in accordance with requirements of the National Environmental Policy Act (NEPA).
- (11) Take an active role in water conservation and recharge efforts by implementing

some or all of the proposed projects found in Appendix A, which is hereby incorporated in and made part of this MOA.

(12) Implement all measures and projects listed in Appendix B.

(13) Consult with the Service on any action authorized, funded, or carried out, in whole or in part, by the Army that may affect endangered and threatened species or critical habitat as provided for in 50 C.F.R. 402, Interagency Cooperation under the Endangered Species Act of 1973, as amended.

6. Terms of this MOA.

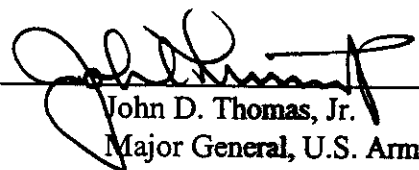
a. Nothing in this MOA will be interpreted to diminish the authorities or responsibilities of the Army or the Service to comply with 50 C.F.R. 402, Interagency Cooperation under the Endangered Species Act of 1973, as amended, or any other relevant statutes or regulations.

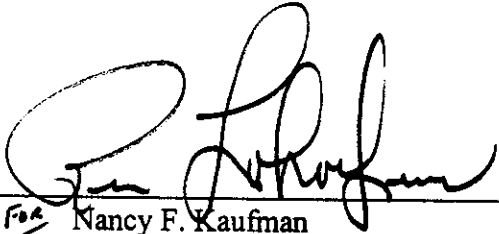
b. This MOA authorizes the transfer of funds to support purposes related to this agreement.

c. This MOA will not affect either party's rights or responsibilities, to include, but not limited to, claims or objections in a statewide water rights adjudication titled, "In re General Adjudication of All Rights to Use Water in the Gila River System and Source" and, "In re Fort Huachuca, No W1-11-605 (Arizona Super. Ct., filed 7 May 1992).

d. Any proposed amendment or modification to this MOA must be in writing and signed by both parties.

7. Effective date. In witness whereof, each party hereto has caused this MOA to be executed by an authorized official on the day and year set forth by their signature. This MOA will become effective upon the date of the final signature.


John D. Thomas, Jr.
Major General, U.S. Army
Commander
U.S. Army Intelligence Center
and Fort Huachuca


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Date: 3 SEP 99

Date: October 27, 1999

APPENDIX A

ARMY WATER RESOURCES MANAGEMENT PLAN

I. The primary purpose of this Army Water Resources Management Plan (AWRMP) is to maintain the Army's mission at Fort Huachuca while protecting and maintaining populations of listed species and their habitats. To meet this goal, the Army will reduce its impact on the subwatershed's water resources. Towards this end, the Army will identify potential water conservation and effluent reuse and recharge projects for implementation. The Army will continue to reduce its annual net water consumption (pumping minus recharge) over the next 10 years. Proposed projects may be implemented off lands under Army ownership or control. Implementation of specific projects must not interfere with the Army's national defense or national security mission. In recognition of uncertainties with recharge technology, mission changes, etc., the Army will consult with the Service on any changes in the Army's ability to reduce its net water consumption over the next 10 years.

In addition to the measures listed above, the Army agrees to the following measures to support the goal of the AWRMP:

- A. Conserving water use by all users to the level necessary to meet, but not exceed, their basic and reasonable needs,
- B. Implementing measures to limit the growth of the cone of depression caused by pumping, to serve Fort Huachuca and the City of Sierra Vista,
- C. Developing a monitoring program designed to assess progress,
- D. Or other actions that may be identified through the planning process that would contribute to meeting the goal of the AWRMP.

II. This AWRMP includes potential water conservation and recharge projects, which the Army will seek to have incorporated into the USPP Plan. Annex 1 of this appendix is a Memorandum of Understanding which establishes the USPP. The USPP was created in 1998 and has already made significant progress, including developing a list of potential water conservation and recharge projects that could be implemented in the subwatershed. This list is included as Annex 2. The Army will continue to be an active participant within the USPP, setting an example through its implementation of the projects specified in paragraphs V and VI below.

III. The Army's water resources management efforts are intended to complement ongoing

and future water conservation and recharge efforts carried out by city, county, state, federal and private entities within the subwatershed. A major initiative currently underway is Sierra Vista's effluent recharge partnership with the Bureau of Reclamation, BLM and the Service. Estimated annual recharge from this effort is 2,000 acre feet.

IV. The Service and the Army agree that a general concept to be used in preparing and implementing a USPP Plan will be that each water user within the subwatershed should mitigate their own impact on the subwatershed's water resources and contribute to a regional effort to achieve the goal of the USPP Plan. The Army will actively participate in the development of a USPP Plan for the subwatershed, including providing funding, technical assistance, and other support as needed for the USPP to complete and begin implementation of a Regional Water Resources Management Plan within three years. This USPP Plan should help identify, prioritize and implement comprehensive water conservation and recharge policies and projects to assist in meeting water needs in the subwatershed. The Army will work within the USPP to maintain the Army's mission at Fort Huachuca while protecting and maintaining populations of listed species and their habitats.

V. In order to reduce net annual water consumption, the Army will implement some or all of the following water conservation measures, and/or other measures identified during the planning process:

- A. Winning the Infrastructure War (demolition of excess buildings and infrastructure)
- B. Modernize golf course irrigation system
- C. Installation of additional waterless urinals in high use areas
- D. Xeriscaping of lawns around buildings
- E. Use of gray water in residential and barrack areas
- F. Conduct periodic water leak detection surveys
- G. Change watering policy and aggressively enforce it
- H. Implement conservation technology
- I. Closure of garden plots

VI. In order to reduce net water consumption, the Army will implement some or all of the following water recharge and effluent reuse projects, and/or other measures identified during the planning process:

- A. Measure effluent and stormwater recharge from East Range effluent ponds
- B. Reengineer East Range effluent ponds to increase recharge
- C. Implement Hatfield pilot recharge project
- D. Study and implement Huachuca Creek recharge project
- E. Restore East Range drainages to increase recharge
- F. Implement Buffalo Soldier Trail recharge project
- G. Capture water discharge into sanitary sewer
- H. Capture additional stormwater

- I. Encourage community water reclamation projects
- J. Support pilot in-channel recharge/erosion control projects
- K. Eliminate groundwater pumping near the SPRNCA

VII. In addition to implementing some or all of the proposed projects above, the Army will continue to support hydrogeologic research in the subwatershed to gain a better understanding of the hydrology and how it may be affected by cultural water uses. It is important to accurately define the cone of depression and implement recharge projects to benefit surface flow in the San Pedro River. Funded by the Army in fiscal years 97 and 98 (\$360K) through a partnership with USGS, geophysical hydrology subsurface surveys are an important tool in understanding this physical system. The data provide insight into the cone of depression, underground reserves, and structures, which impact flow to the San Pedro River. Ongoing work will provide additional information to improve water management in the subwatershed. In addition, areas of the subwatershed will be resurveyed and compared to baseline information. Future efforts will provide validation of recharge estimates and changes in the hydrologic regime. Another important Army initiative is the Alternatives Futures Study. This effort, already funded at approximately \$2M, will provide optional scenarios for integrated ecosystem planning and management for the subwatershed. The study will incorporate some data from Mexico, where the headwaters of the San Pedro River are located, and may help to identify some water use savings that could be captured through international cooperative efforts.

VIII. In addition to active participation in the USPP, the Army will continue to cooperate with local, state, and federal entities on workgroups and technical information sharing (Technical Review Committee), in close coordination with surrounding communities and Cochise County.

IX. The AWRMP will be reviewed annually by the Service. The Army will prepare an annual written report to the Service documenting progress and results in implementation of proposed projects.

X. Project Leaders

A. Project Leader for the Service will be:

1. Project Leader: Tom Gatz
Telephone: (602) 640-2720
Fax: (602) 640-2730
2. Manager: Jim Rorabaugh
Telephone: (602) 640-2720
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B. Project Leader for the Army will be:

1. Project Leader: **Thomas G. Cochran**
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2. Manager: **James Hessel**
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APPENDIX B

ARMY REQUIREMENTS FROM CURRENT FORMAL CONSULTATION

Huachuca Water Umbel

1. The Fort shall construct rock barriers around Huachuca water umbel populations.
2. The Fort shall initiate prescribed fire and fuel management in the Huachuca Mountains.
3. The Fort shall close roads and fire breaks to vehicle travel in the immediate watersheds of water umbel populations in the Huachuca Mountains where vehicle travel is causing erosion, and where that erosion could result in scouring or sedimentation of downstream water umbel populations (the Fort will coordinate with the Service in identifying roads and fire breaks needing closure).
4. The Fort shall maintain the barrier to vehicle travel at Gate No. 7.
5. Beginning in 1999 and continuing through 2009, the Fort shall provide annual monitoring of Huachuca water umbel populations at Fort Huachuca and, in coordination with the BLM, throughout the SPRNCA. Monitoring protocols shall be coordinated with the Service.
6. Beginning with the date of this opinion, during fire suppression, prescribed fire, and managed natural fire activities in Garden, McClure, or Sawmill canyons, the following measures shall be implemented:
 - a. One of the objectives of fire activities shall be protection of Huachuca water umbel populations. This objective will not in any way constrain the fire boss from taking any action as needed to protect life or property.
 - b. A Resource Advisor(s) shall be on the fire during all activities. Resource Advisors shall be qualified biologists designated to coordinate Huachuca water umbel-related concerns and serve as an advisor to the fire boss. They shall also serve as field contact representatives responsible for coordination with the Service. They shall monitor fire activities to ensure the protective measures endorsed by the fire boss are implemented. Resource Advisors shall be on call 24 hours a day during the fire season.
 - c. Off-road vehicle activity shall be kept to a minimum. Vehicles shall be parked as close to roads as possible, and vehicles shall use wide spots in roads or disturbed areas to turn around. If off-road travel is necessary, local fire-fighting units should go off-road first because of their prior knowledge of the area.

d. Use of tracked vehicles shall be restricted to improving roads or constructing lines where a short distance of line might save a large area from fire.

e. The Fort shall, to the extent possible, obliterate vehicle tracks made during the fire, especially those of tracked vehicles.

f. Areas disturbed for crew camps, landing strips, staging areas, and any other new areas of disturbance created during the fire shall be kept to the minimum area possible and shall be located in previously disturbed sites whenever possible. No such areas shall be located at or immediately upstream of Huachuca water umbel sites.

g. A mitigation/monitoring plan shall be developed by the Fort in coordination with the Service for each prescribed fire, managed natural fire, or fuels treatment that may adversely affect the Huachuca water umbel. The mitigation/monitoring plan shall ensure that adverse effects to Huachuca water umbel and its habitat are minimized. The effects of prescribed fire and fuels treatment on the water umbel and its habitat shall also be monitored. Mitigation/monitoring plans shall be approved by the Service prior to implementing prescribed fire or fuels management. Mitigation and monitoring for managed natural fire that may adversely affect the Huachuca water umbel shall be coordinated with and approved by the Service as soon as possible after a decision is made to let a natural fire burn under controlled conditions.

7. The Fort shall fund water umbel habitat management or restoration where habitat has been degraded or lost, or where potential exists for creating water umbel habitat. Assistance shall take the form of funding and/or technical assistance. Projects funded should include both off-post and on-post projects. On-post activities could include restoration and protection of cienega conditions in Garden Canyon and other wetted sites. Off-post, the Fort could assist BLM, the Coronado National Forest, or other land owners/managers of water umbel habitat potentially affected by the proposed action. Off-post projects that the Fort should consider funding include cienega restoration or protection in Scotia Canyon or elsewhere in the Huachuca Mountains, if approved by and coordinated with the Coronado National Forest, and restoration or protection of cienega conditions on the San Pedro RNCA, if approved by and coordinated with the Bureau of Land Management. All plans and agreements for funded projects shall be coordinated with and approved by the Service.

Southwestern Willow Flycatcher

1. The Fort shall maintain existing fire breaks on the perimeter of Area ZULU and on the eastern boundary of the East Range.

2. The Fort shall vigorously suppress any fire on the eastern third of the East Range, except in the impact area, and implement all portions of the proposed action and proposed mitigation

measures relevant to fire suppression on the East Range.

3. If surveys confirm presence of southwestern willow flycatchers on Fort Huachuca, the Fort shall take action to ensure that fire ignited on the training ranges does not spread to flycatcher habitat and shall work with the Service to develop and implement a plan to prevent any take of flycatchers.
4. The Fort shall promptly assess habitat suitability for flycatchers at Research, Development, Testing, and Evaluation (RDTE) survey points along the San Pedro River or in other areas. If suitable habitat occurs during the life of the project within 300 feet of a RDTE survey point, or a fire ignited at a RDTE survey point could reasonably spread to suitable habitat of the flycatcher, the Fort shall take all precautions to prevent take as follows:
 - a. The Fort shall not authorize use of RDTE survey points located within 300 feet of suitable habitat of the southwestern willow flycatcher from April 1 to September 1 of each year.
 - b. If suitable habitat occurs adjacent to a RDTE survey point, but farther than 300 feet from it, the Fort shall ensure that all precautions are taken to ensure fire is not ignited by personnel or activities at the RDTE survey point which then spreads to flycatcher habitat. Such precautions shall include maintaining functional fire extinguishers with all vehicles and informing all personnel at RDTE survey points of the need to take action as necessary to prevent wildfire ignitions. Personnel should be especially careful with cigarettes.
5. Beginning in 2000 and continuing through 2009, the Fort shall fund comprehensive annual status surveys for southwestern willow flycatcher at all suitable habitats potentially affected by the proposed action. This includes habitat on Fort Huachuca, at the Babocomari Cienega, if permission is obtained, and throughout the SPRNCA in cooperation with the BLM. Surveys shall adhere to Service protocol (Sogge *et al.* 1997). Surveys shall include documenting flycatcher population size and distribution; identity of nesting birds (if banded); number of nesting attempts, clutch sizes, hatching success, fledgling success; causes of nest loss or failure; breeding season length; and habitat use.
6. The Fort shall monitor habitat conditions in the SPRNCA and any habitats acquired or for which easements/permission to enter are obtained. Aerial photos (1"=500 feet) shall be taken of the riparian corridor in 2000, 2004, and 2008 and vegetation maps constructed from each photo series within one year of obtaining the photographs. Resolution of the mapping effort shall be sufficient to map vegetation patches as small as 10 acres. Vegetation typing shall be by plant species composition and vertical structure/foliage density. Sufficient ground-truthing shall be conducted to assure reasonable accuracy of the mapping effort. Vegetation mapping in 2004 and 2008 shall be accompanied by a trend analysis to determine gains or losses in flycatcher habitat. If loss of flycatcher habitat occurs between surveys, the loss is attributable to activities of the Fort (including groundwater pumping), the Fort shall reinitiate consultation.

7. The Fort shall assist BLM or other land owners/managers of habitat on the Upper San Pedro River with flycatcher habitat management, or restoration on retired agricultural lands, grazed areas, and in other areas where flycatcher habitat has been degraded or lost. Assistance shall take the form of funding and/or technical assistance. Projects could include, but are not limited to, working with the BLM and others to restore hydrology and riparian woodlands on retired agricultural or other previously disturbed lands in the floodplain; restoration of watershed condition by improved grazing management, removal of cattle, erosion control, or other measures in uplands adjacent to the San Pedro River; cowbird trapping and control; and protection of existing flycatcher habitat from fire or recreational impacts. All plans and agreements for projects funded shall be coordinated with and approved by the Service.

Peregrine Falcon

The peregrine falcon was delisted during formal consultation; therefore, all reasonable and prudent measures and terms and conditions are no longer required. However, Fort Huachuca plans to continue implementing agreed upon measures to assist recovery efforts for the falcon.

1. The Fort shall provide environmental awareness training to personnel. Personnel training in the Huachuca Mountains shall, through the environmental awareness training, be made aware of the protected status of the peregrine falcon and these terms and conditions, but specific locations of peregrine falcon eyries shall not be revealed unless absolutely necessary to protect the species.
2. Fort Huachuca shall, in accordance with survey protocol (Ward 1994), conduct annual monitoring of potential peregrine falcon nest sites at Fort Huachuca early in the breeding season so that training and other activities can be designed or revised, as needed, to avoid or minimize adverse effects.
3. Within canyons containing active peregrine falcon eyries, the Fort shall minimize low-level helicopter flights within 1.0 mile of active eyries. Helicopter flights closer than 0.5 mile to active eyries shall be prohibited.
4. If peregrine falcons are found nesting in Garden Canyon within 0.25 mile of the rappelling cliffs, rappelling shall be halted or moved at least one mile from the nest until the nestlings fledge.
5. The Fort shall establish a schedule and implement as soon as possible prescribed burns and/or fuels management to reduce fuel loading in Fort Huachuca woodlands, thereby reducing the potential for stand-replacing wildfires in peregrine falcon foraging and nesting habitat.
6. One of the objectives of fire suppression activities in the Huachuca Mountains shall be protection of peregrine falcon nesting and foraging habitats. This objective will not in any way constrain the fire boss from taking any action as needed to protect life or property.

7. A Resource Advisor(s) shall be on the fire during all suppression, prescribed fire, or managed natural fire activities in the Huachuca Mountains. Resource Advisors shall be qualified biologists designated to coordinate peregrine falcon concerns and serve as an advisor to the fire boss. They shall also serve as field contact representatives responsible for coordination with the Service. They shall monitor fire suppression activities to ensure protective measures endorsed by the fire boss are implemented. Resource Advisors shall be on call 24 hours.
8. Areas of significant human activity during fire suppression operations, prescribed fire, or managed natural fire in the Huachuca Mountains, including fire crew camps, landing strips, and equipment staging areas, shall not be located within 1.0 mile of active peregrine falcon eyries, and areas disturbed during the fire shall be kept to the minimum area possible and shall be located in previously disturbed sites whenever possible.
9. Off-road vehicle activity during fire activities in the Huachuca Mountains shall be kept to a minimum. Vehicles shall be parked as close to roads as possible, and vehicles shall use wide spots in roads or disturbed areas to turn around. If off-road travel is necessary, local fire-fighting units should go off-road first because of their prior knowledge of the area.
10. Use of tracked vehicles during fire activities in the Huachuca Mountains shall be restricted to improving roads or constructing lines where a short distance of line might save a large area from fire.
11. The Fort shall, to the extent possible, obliterate vehicle tracks made during fires in the Huachuca Mountains, especially those of tracked vehicles.
12. Patches of unburned vegetation within burned areas in the Huachuca Mountains shall not be burned out as a fire suppression measure, except as needed to secure the fire perimeter or provide for fire fighter safety.
13. A mitigation/monitoring plan shall be developed by the Fort in coordination with the Service for each prescribed fire, managed natural fire, or fuels treatment that may adversely affect the peregrine falcon. The mitigation/monitoring plan shall ensure that adverse effects to peregrine falcons and their habitat are minimized. The effects of fire activities and fuels treatment on the peregrine falcon and its habitat shall also be monitored. The Service shall approve mitigation/monitoring plans. Mitigation and monitoring for managed natural fire that may adversely affect the peregrine falcon shall be coordinated with and approved by the Service as soon as possible after a decision is made to let a natural fire burn under controlled conditions.
14. The Fort shall monitor take of peregrine falcons and document any disturbance of nest sites. The results of monitoring specified here and elsewhere in this section will be reported to the Service pursuant to the "reporting requirements" below.

Mexican Spotted Owl

1. The Fort shall provide environmental awareness training to personnel. The environmental awareness training shall include instructional/educational materials that will describe the protected status and sensitive nature of the Mexican spotted owl (MSO). Personnel training in the Huachuca Mountains shall, through the environmental awareness training, be made aware of the protected status of the MSO and these mitigation measures, but specific locations of owl nests or Protected Activity Centers (PACs) shall not be revealed unless absolutely necessary to protect the species.
2. Fort Huachuca shall conduct annual monitoring of currently known PACs and surveys of potential MSO habitat at Fort Huachuca in accordance with Service survey protocol.
3. The Fort shall develop, within two years of the date of this opinion, a species-specific management plan for the MSO that conforms to and complements the MSO Recovery Plan.
4. Areas within PACs treated to reduce occurrence of wildfire, prescribed fire or fuels management shall be monitored, as described in the Recovery Plan, to determine effects of the treatment on known owl habitat components. If adverse effects are detected, treatments shall be modified to reduce those effects as much as possible while still reducing the risk of wildfire.
5. Within canyons containing active MSO nests, or in canyons where occupancy or reproductive status is unknown, the Fort shall minimize low-level helicopter flights within 1.0 mile of the nest, or the site of the last previously known nest. Helicopter flights closer than 0.25 mile to active nests shall be prohibited from March 1-August 31.
6. One of the objectives of fire suppression activities in the Huachuca Mountains shall be protection of MSO PACs. This objective will not in any way constrain the fire boss from taking any action as needed to protect life or property.
7. A Resource Advisor(s) shall be on the fire during all suppression, prescribed fire, or managed natural fire activities in the Huachuca Mountains. Resource Advisors shall be qualified biologists with knowledge of the MSO and its habitat. The Resource Advisor shall possess maps of all PACs and all potential nest/roost habitats in the project area and vicinity. Resource Advisor(s) shall coordinate MSO concerns and serve as an advisor to the fire boss. They shall also serve as field contact representatives responsible for coordination with the Service. They shall monitor fire suppression activities to ensure protective measures endorsed by the fire boss are implemented. Resource Advisors shall be on call 24 hours.
8. If a MSO is encountered during the fire, the Resource Advisor shall be advised immediately. The Resource Advisor shall assess potential harm to the owl and advise the fire boss of methods to prevent harm. The Resource Advisor shall maintain a record of any Mexican spotted owls

encountered during suppression activities. The information shall include for each owl the location, date, and time of observation and the general condition of the owl, and response to the fire and fire activities.

9. Areas of significant human activity during fire suppression operations, prescribed fire, or managed natural fire in the Huachuca Mountains, such as fire crew camps, landing strips, and equipment staging areas, shall be located outside of PACs. Areas disturbed during fire suppression activities in the Huachuca Mountains, such as fire lines, crew camps, and staging areas shall be rehabilitated, including the obliteration of fire lines to prevent their use by vehicles or hikers.
10. All fire suppression actions in PACs will occur, to the maximum extent possible, using "light on the land" methods, including not removing trees over 9 inches diameter at breast height (dbh) unless it is deemed necessary by the fire boss to prevent the fire from effecting additional PAC acres, or to protect life or property.
11. Patches of unburned vegetation within burned areas in the Huachuca Mountains shall not be burned out as a fire suppression measure, except as needed to secure the fire perimeter or provide for fire fighter safety.
12. Off-road vehicle activity shall be kept to a minimum during fire activities in the Huachuca Mountains. Vehicles shall be parked as close to roads as possible, and vehicles shall use wide spots in roads or disturbed areas to turn around. If off-road travel is necessary, local fire-fighting units should go off-road first because of their prior knowledge of the area.
13. Use of tracked vehicles during fire activities in the Huachuca Mountains shall be restricted to improving roads or constructing lines where a short distance of line might save a large area from fire.
14. The Fort shall, to the extent possible, obliterate vehicle tracks made during the fire activities in the Huachuca Mountains, especially those of tracked vehicles.
15. The Fort in coordination with the Service shall develop a mitigation/monitoring plan for each prescribed fire, managed natural fire, or fuels treatment that may adversely affect the MSO. Prescribed fire and fuels treatment shall be designed to protect MSOs and their habitat. The mitigation/monitoring plan shall contain the following, at a minimum:
 - a. Treatments/prescribed fire shall not occur within a 100 acre area around spotted owl nest sites. This 100 area shall include habitat that resembles the structural and floristic characteristics of the nest site. The 100 acre area will be protected by using topographic and other barriers, or through line construction. All line construction in PACs will occur outside the MSO breeding season, will not remove any trees larger than 9 inches dbh unless they pose a threat to the safety of fire fighters, and will only occur with a wildlife biologist from the Fort on-site.

b. Treatments shall enhance or retain owl habitat components, such as downed large logs greater than 12 inches in midpoint diameter, hardwoods, grasses, forbs, and shrubs, while still reducing the chance of wildfire. In regard to downed logs, this shall be achieved by protecting 80-90 percent of the downed logs 12 inches diameter and greater, and hand-lining snags 18 inches dbh and greater for all managed natural fire actions within PACs.

c. Treatments shall produce a mosaic of habitat components within PACs.

d. Prescribed or managed natural fire shall be introduced in PACs in blocks of 100-acres or less, and only between September 1 and February 28, outside the MSO breeding season.

e. Prescribed or managed natural fire shall be introduced into potential MSO nest/roost habitat only if at least two years of surveys, in accordance with Service protocol has been conducted, and for which one year of follow-up survey (four visits) has been conducted, if more than one breeding season has elapsed since the last survey to protocol and the action. Furthermore, introduction of fire into PACs shall only occur if the nest/roost site is known the year of the action, or for which nest/roost site information is less than three years old. If nest/roost information for a PAC is three years old or more, a 200-acre nest buffer shall be deferred from treatment until such a time, as the nest/roost can be located again.

f. All prescribed or managed natural fire shall be suppressed if it is anticipated that the fire may burn out of prescription in the following 24 hours. The Fort may choose to suppress actions prior to this.

g. For prescribed or managed natural fire, the Fort shall ensure that no more than 10 percent of the canopy of each PAC will be effected by gaps created by single or groups of trees crowning. Groups of trees that "crown out" shall not exceed two acres in size.

h. The Fort shall ensure that no more than two PACs per year on Fort Huachuca are affected by prescribed or managed natural fire. A PAC is considered affected if one or more acres of the PAC are burned to any degree. If prescribed or managed natural fires in one year are located in PAC(s) outside of the nest buffer, and are 1-10 acres in size, the Fort will discuss with the Service the option of allowing prescribed or managed natural fire to occur in one additional (or the same) PAC.

i. The effects of prescribed fire, managed natural fire, and fuels treatment on the owl and its habitat shall be monitored. Such monitoring shall include quantifying acres of 100-acre activity centers, PACs, and potential habitat affected by these activities.

j. The Service shall approve Mitigation/monitoring plans. Such plans shall be developed prior to implementation of prescribed fire. Mitigation and monitoring for managed natural fire that may adversely affect the MSO shall be coordinated with and approved by the Service as soon

as possible after a decision is made to let a natural fire burn under controlled conditions.

16. If MSOs are found nesting in Garden Canyon within 0.25 mile of the rappelling cliffs, rappelling shall be halted or moved at least 0.25 mile from the active nest from March 1 through August 31, or until nestlings fledge.

17. The Fort shall post, by October 31, 1999, a permanent all-weather sign near the Scheelite Canyon trailhead (but not visible from the Garden Canyon Road) that, at a minimum, informs visitors of the following:

- a. The Canyon is home to sensitive species.
- b. Visitors should stay on the trail and be as quiet and unobtrusive as possible.
- c. Groups of visitors are limited to 12 or less.
- d. Calling, hooting, or playing of taped recordings to elicit responses from or to locate owls is prohibited in Scheelite Canyon without special permit from the U.S. Fish and Wildlife Service.
- e. Smoking is prohibited.

18. The Fort shall monitor take of MSOs and document any disturbance of owls or owl habitat. This and other monitoring required here will be reported to the Service pursuant to the "reporting requirements" described below.

Lesser Long-nosed Bat

1. The Fort shall ensure that construction, upgrading, or maintenance of roads does not increase or facilitate public access to Manila Mine, Pyeatt Cave, or other day roosts identified during the life of the project.

2. In coordination with the Service, the Fort shall consider installing bat gates with lockable human access doors at Manila Mine, Pyeatt Cave, and other day roosts that may be identified during the life of the project. Decisions to install gates and the design of the gates shall be approved by the Service.

3. If bat gates are not installed, then from at least July 1 to October 31 the Fort shall ensure that the alarm system is functional; access routes to day roosts are closed; access routes at the closures and the mine/cave sites are posted with the following information: no vehicle access, no entry into mines or caves, explanations that the closures are needed to protect sensitive species, and warnings that entry into the mines/caves could represent a violation of the Endangered Species Act.

4. If an annual increase in illegal entry into day roosts is noted, the Fort shall take action to correct the problem. Corrective action could include bat gates.

5. The Fort shall prohibit low-level helicopter flights within 350 feet of Pyeatt Cave, Manila Mine, or other day roosts identified during the life of the project from July 1 to October 31.
6. Prior to construction activities, pre-construction surveys shall be conducted ~~for~~ paniculate agaves that may be directly affected by construction activities. If agaves are ~~found~~ during pre-construction surveys, the following measures shall be implemented:
 - a. Disturbance shall be limited to the smallest area practicable, damage to ~~agaves~~ shall be avoided where possible, and projects shall be located in previously disturbed ~~areas~~ whenever possible.
 - b. Vehicle use shall be limited to existing routes and areas of disturbance ~~except~~ as necessary to access or define boundaries for new areas of construction or operation.
 - c. All workers shall strictly limit their activities and vehicles to designated ~~areas~~. Construction workers shall be informed of these terms and conditions.
7. No seeding/planting of nonnative grasses or other plants shall occur at Fort Huachuca that may alter fire frequencies in wildland areas.
8. Prescribed fire and managed natural fire shall be planned to minimize ~~adverse~~ effects to lesser long-nosed bat forage plants and roosts. Measures shall be developed to ensure ~~the~~ the following:
 - a. The fire kills no more than 20 percent of agaves that are burned during ~~prescribed~~ fire or managed natural fire.
 - b. Fires in agave management areas shall be actively suppressed unless ~~the area~~ is approaching its natural fire return interval of 10 years.
 - c. Prescribed fire shall be prohibited in agave management areas where ~~greater~~ than half of those agaves are young age classes (agaves with four or fewer spiral courses ~~of leaves~~).
 - d. A mitigation plan shall be developed by the Fort in coordination with ~~the~~ Service for each prescribed or managed natural fire within 0.5 mile of a lesser long-nosed bat ~~roost~~ or in areas that support paniculate agaves. The mitigation plan shall ensure those effects to ~~lesser~~ long-nosed bat roosts and forage plants are minimized and shall include monitoring of effects ~~to~~ forage plants. The Service shall approve the plan. Mitigation and monitoring for managed ~~natural~~ fire shall be coordinated with and approved by the Service as soon as possible after a ~~decision~~ is made to let a natural fire burn under controlled conditions.
 - e. A schedule for prescribed burns shall be established and followed to ~~reduce~~ fuel loading in Fort Huachuca grasslands and woodlands, thereby reducing the potential for ~~major~~ wildfires in

lesser long-nosed bat foraging and roosting habitat. This schedule shall be coordinated and approved by the Service.

f. In regard to fire suppression, prescribed fire, or managed natural fire activities on the West or South Ranges, the following measures shall be implemented:

(1) The Fort shall continue the mutual aid agreements with local governments and the Memorandum of Understanding with the Coronado National Forest to provide assistance in fire suppression, if participating entities agree.

(2) One of the objectives of fire suppression, prescribed fire, and managed natural fire activities shall be protection of lesser long-nosed bat foraging and roosting habitats. This objective will not in any way constrain the fire boss from taking any action as needed to protect life or property.

(3) A Resource Advisor(s) shall be on the fire during all suppression, prescribed fire, or managed natural fire activities. Resource Advisors shall be qualified biologists designated to coordinate lesser long-nosed bat concerns and serve as an advisor to the fire boss. They shall also serve as field contact representatives responsible for coordination with the Service. They shall monitor fire activities to ensure protective measures endorsed by the fire boss are implemented. Resource Advisors shall be on call 24 hours.

(4) Areas of significant human activity during fire suppression operations, such as fire crew camps, landing strips, and equipment staging areas, shall not be located from July 1 through October 31 within 0.25 mile of Manila Mine, Pyeatt Cave, Wren Bridge, or other roosts identified during the life of the project. Such areas shall also be kept to the minimum area possible and shall be located in previously disturbed sites whenever possible.

(5) Off-road vehicle activity during fire activities shall be kept to a minimum. Vehicles shall be parked as close to roads as possible, and vehicles shall use wide spots in roads or disturbed areas to turn around. If off-road travel is necessary, local fire-fighting units should go off-road first because of their prior knowledge of the area.

(6) Use of tracked vehicles during fire activities shall be restricted to improving roads or constructing lines where a short distance of line might save a large area from fire.

(7) The Fort shall, to the extent possible, obliterate vehicle tracks made during fires in the Huachuca Mountains, especially those of tracked vehicles.

(8) Patches of unburned vegetation within burned areas in the Huachuca Mountains shall not be burned out as a fire suppression measure, except as needed to secure the fire perimeter or provide for fire fighter safety.

9. Night-time training shall not occur in agave management areas from July 1 through October 31.
10. No nighttime use and no tracer fire shall occur on live fire ranges 2, 3, and 4 from July 1 through October 31.
11. From July 1 - October 31, all nocturnal UAV operations at the Rugge-Hamilton and Pioneer sites will be above 500 feet above ground level, except for take-off and landings. Take-off and landing approaches at Rugge-Hamilton will be confined to the east and north and approaches at Pioneer will be confined to the north and west, away from agave management areas. Nocturnal rocket-assisted take-offs of UAVs from the Black Tower site shall only occur from November through June. Rocket-assisted take-offs shall be attended by fire crews due to the high probability of fire and potential adverse effects to agave communities.
12. Off-road vehicle travel shall not occur in protected agave management areas or any other part of the West Range or South Range.
13. Pyrotechnics shall not be used within 0.25 miles of protected agave management areas.
14. The Fort shall fully implement as soon as possible the Agave Management Plan (Howell and Robinett 1996), with the exception of the recommendation to limit prescribed fire to the cool season (November through March). Alternatively, the Fort could rewrite the Agave Management Plan and implement that revised plan, if approved by the Service. In either case, the Agave Management Plan should evolve with monitoring data and research results. Any changes in future agave management shall be reviewed and approved by the Service.
15. The Fort shall (if funding is available) continue implementation of Integrated Training Area Management (ITAM), or shall otherwise provide environmental awareness training to all military personnel that work in the field on the West or South Range. Environmental awareness training shall include information on the status of the lesser long-nosed bat and these terms and conditions. The Fort shall continue to implement Fort Huachuca Regulation 385-8, Range and Training Area Operations, to specify the completion of environmental awareness training (including protected resource identification) prior to the initiation of training or testing; and the responsibility of the unit commander to become familiarized with environmental policies and operational requirements.
16. The Fort shall designate a point of contact at Range Control that will ensure that training activities comply with mitigation requirements.
17. The Fort shall develop, as soon as possible, a species-specific management plan for the lesser long-nosed bat.
18. The Fort shall conduct annual monitoring of known or potential lesser long-nosed bat roosts

at Fort Huachuca so that training and other activities can be designed or revised, as needed, to avoid or minimize adverse effects.

19. The Fort shall conduct monitoring of Palmer's agave populations on the West and South Ranges every five years. The objective of the monitoring shall be to establish trends in bat forage resources.

20. The Fort shall monitor take of lesser long-nosed bats, document any disturbance of roost sites, and document acres burned on the West or South ranges and whether such fire burned in agave management areas. The results of this monitoring shall be reported to the Service pursuant to the "reporting requirements" below.

Sonora Tiger Salamander

1. The Fort shall provide environmental awareness training to personnel. Environmental training of personnel working in upper Garden Canyon shall include instructional/educational materials that will describe the protected status and sensitive nature of the Sonora tiger salamander and prohibitions on transport and release of live fish and salamanders, collection of Sonora tiger salamanders, and off-road vehicle activity.

2. The Fort shall continue the mutual aid agreements with local governments and the Memorandum of Understanding with the Coronado National Forest to provide assistance in fire suppression, if participating entities agree.

3. Fort Huachuca shall conduct annual monitoring of the upper Garden Canyon pond in June or early July (pre-monsoon) of each year to determine condition of the habitat and presence of aquatic salamanders according to protocol approved by the Service.

4. The Fort shall develop, as soon as possible, a species-specific management plan for the Sonora tiger salamander.

5. The Fort shall establish a schedule and implement as soon as possible prescribed burns and/or fuels management to reduce fuel loading in Fort Huachuca woodlands.

6. Exclosure fences or other barriers, such as boulders placed around the pond's perimeter, shall be constructed, as soon as possible, but before September 30 1999, at upper Garden Canyon Pond to prevent vehicles from driving through the habitat.

7. A closure to vehicle travel shall be maintained for the life of the project at Gate No. 7.

8. The Fort shall amend part 4.i. of the "Fishing Facts" handed out to anglers to read: "i. Live fish and salamanders may not be transported or used as bait on Fort Huachuca. Capture,

transport, or release of salamanders is strictly prohibited." This shall appear in bold. The "Fishing Facts" shall be amended as described by October 31, 1999 and shall be supplied to all persons obtaining fishing permits at Fort Huachuca.

9. By October 31, 1999, a permanent all-weather sign shall be posted at upper Garden Canyon pond. The sign shall contain the following information at a minimum: 1. Fishing, use of nets, and capture or release of salamanders or fish is prohibited, and 2. Off-road vehicle use is prohibited.

10. One of the objectives of fire suppression activities shall be protection of salamanders and the aquatic habitat at upper Garden Canyon pond, in Scotia Canyon, or other salamander localities possibly affected by fire at Fort Huachuca. This objective will not in any way constrain the fire boss from taking any action as needed to protect life or property.

11. A Resource Advisor(s) shall be on the fire during all suppression, prescribed fire, or managed natural fire activities in the Huachuca Mountains. Resource Advisors shall be qualified biologists designated to coordinate Sonora tiger salamander concerns and serve as an advisor to the fire boss. They shall also serve as field contact representatives responsible for coordination with the Service. They shall monitor fire activities to ensure protective measures endorsed by the fire boss are implemented. Resource Advisors shall be on call 24 hours.

12. Areas of significant human activity during fire suppression operations, such as fire crew camps, landing strips, and equipment staging areas, shall not be located on or adjacent to salamander breeding sites in Garden Canyon or at other sites identified during the life of the project. Such areas of human activities shall also be kept to the minimum area possible and shall be located in previously disturbed sites whenever possible.

13. Off-road vehicle activity during fire activities in the Huachuca Mountains shall be kept to a minimum. Vehicles shall be parked as close to roads as possible, and vehicles shall use wide spots in roads or disturbed areas to turn around. If off-road travel is necessary, local fire-fighting units should go off-road first because of their prior knowledge of the area.

14. Use of tracked vehicles during fire activities in the Huachuca Mountains shall be restricted to improving roads or constructing lines where a short distance of line might save a large area from fire.

15. The Fort shall, to the extent possible, obliterate vehicle tracks made during fires in the Huachuca Mountains, especially those of tracked vehicles.

16. Patches of unburned vegetation within burned areas in the Huachuca Mountains shall not be burned out as a fire suppression measure, except as needed to secure the fire perimeter or provide for fire fighter safety.

17. A mitigation/monitoring plan shall be developed by the Fort in coordination with the Service for each prescribed fire, managed natural fire, or fuels treatment that may adversely affect the Sonora tiger salamander or its habitat on or off-post. Fire activities and fuels treatment shall be designed to protect Sonora tiger salamanders and their habitat. The effects fire activities and fuels treatment on the Sonora tiger salamander and its habitat shall be monitored.

Mitigation/monitoring plans shall be approved by the Service. Mitigation and monitoring for managed natural fire that may adversely affect the Sonora tiger salamander shall be coordinated with and approved by the Service as soon as possible after a decision is made to let a natural fire burn under controlled conditions.

18. The Fort shall monitor take of Sonora tiger salamanders and document any disturbance of salamanders or salamander habitat. Results of this and other monitoring required herein shall be reported to the Service pursuant to the "reporting requirements" below.

Reporting Requirements

For ten years from the date of this opinion, the Fort shall prepare and deliver to the Service annual reports documenting progress/results in implementation of these mitigation measures, including actions taken, problems encountered, any take of listed species documented, copies of reports and data sheets for habitat monitoring and species surveys, effectiveness of the mitigation measures, and recommendations on how to modify the measures to enhance protection of listed species or reduce needless hardship on the Fort or its contractors. Reports shall be due January 31 of each year from 2000-2009. The final report shall be due 60 days after the date of this opinion in 2009.

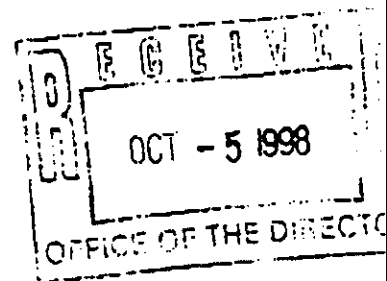
General Mitigation Measures the Army Proposes to Reduce Adverse Effects to Listed Species and Their Habitats

1. The Fort shall continue the mutual aid agreements with local governments and the Memorandum of Understanding with the Coronado National Forest to provide assistance in fire suppression, if participating entities agree.

2. The Fort shall continue to implement Fort Huachuca Regulation 385-8, Range and Training Area Operations, to specify the completion of environmental awareness training (including protected resource identification) prior to the initiation of training or testing; and the responsibility of the unit commander to become familiarized with environmental policies and operational requirements. Personnel training in the Huachuca Mountains shall, through the environmental awareness training, be made aware of the protected status of listed species and these terms and conditions, but specific locations of listed species shall not be revealed unless absolutely necessary to protect the species.

3. The Fort shall develop, as soon as possible, species-specific management plans for all listed species that occur at Fort Huachuca.
4. The Fort shall develop and implement a Fire Management Plan to address suppression and prescribed fire. As part of this planning effort, the Fort shall establish a schedule and implement as soon as possible prescribed burns and/or fuels management to reduce fuel loading in Fort Huachuca woodlands, thereby reducing the potential for stand-replacing wildfires.
5. The Fort shall designate a contact at Range Control to ensure all military training is conducted in compliance with environmental requirements. This would include reviewing training forms and inspecting training and testing units and the use of training areas.
6. The Fort shall implement the East Range Watershed Improvement Plan to improve watershed management on the East Range.
7. The Fort shall continue to periodically monitor and survey for candidate species on Fort Huachuca.
8. The Fort shall revise Fort Huachuca Regulation 385-8, Range and Training Area Operations, to specify environmental policies and operational requirements (i.e. prohibit vehicle entry into agave management areas, etc.).
9. The Fort shall improve recreational management. This includes revising the off-highway vehicle policy and developing a recreational regulation.
10. An Integrated Natural Resources Management Plan will be developed and implemented for Fort Huachuca, as required by the Sikes Improvement Act of 1997 (16 USC 670 *et seq*).

**MEMORANDUM OF UNDERSTANDING
BETWEEN**



The Bureau of Land Management
The Department of Defense - Fort Huachuca
U.S. Forest Service
U.S. Geological Survey
Arizona Department of Water Resources
Arizona Department of Environmental Quality
Arizona State Land Department
Cochise County
City of Sierra Vista
City of Bisbee
The Nature Conservancy
Town of Huachuca City

I. Introduction

This agreement creates a partnership to facilitate and implement sound water resource management and conservation strategies in the Sierra Vista Subwatershed.

This agreement establishes the Upper San Pedro Partnership that will meet as necessary.

II. Purpose

To coordinate and cooperate in the identification, prioritization and implementation of comprehensive policies and projects to assist in meeting water needs in the Sierra Vista Subwatershed of the Upper San Pedro River Basin.

III. Authorities

Bureau of Land Management: Federal Land Policy and Management Act (1976)

Department of Defense-Fort Huachuca: DOD Directive 4000.19, Paragraph 5B

U.S. Forest Service: Organic Act of 1879; Economy Act 601 of 1932

U.S. Geological Survey: Organic Act of 1879; Economy Act 601 of 1932

Arizona Department of Water Resources: Arizona Revised Statutes §§45-105(A)(1) and (8)

Arizona Department of Environmental Quality:

ARS 49-202. A Designation as State Agency for purposes of the Clean Water Act, specifically:

Clean Water Act Section 208 Area-Wide Waste Management

Clean Water Act Section 319 Non Point Source Pollution Control

Arizona State Land Department: ARS Title 37-102

Cochise County: Board of Supervisors

City of Sierra Vista: ARS 11-952

City of Bisbee: ARS 11-952

The Nature Conservancy: Les Corey - TNC, AZ Chapter, State Director

Town of Huachuca City: Mayor of Huachuca City

IV. Cooperation

The parties to this memorandum of understanding agree to the following:

- A. Participate in the Upper San Pedro Partnership that will meet regularly to accomplish the purpose identified in paragraph II.
- B. Assist in identifying sources of funding to meet the objective of sound water management in the subwatershed.

V. Implementation and Administration

The Arizona Department of Water Resources will chair the Upper San Pedro Partnership Committee and provide administrative support. Each participant in this memorandum of understanding will be responsible for briefing their management and coordinating within their individual agency or organization. The Committee will provide a progress report semi-annually for participant and public review. In addition, individual project reports, plans, etc. will be provided as required.

VI. Limitations

Nothing in this agreement shall be construed as limiting or affecting the legal authorities or decision-making of any of the participants of this MOU, or require expenditure of funds. Any party to this agreement may cancel this agreement by written notification at least 30 days prior to the termination date.

Don P. Membrillo
State Director, Bureau of Land Management

8/26/98
Date

see attached sheet
Commander, Fort Huachuca, U.S. Army

Date

Nora Rasmussen
Deputy Forest Supervisor, Coronado National Forest

12-1-98
Date

John B. Smith
District Chief, U.S. Geological Survey

7/27/98
Date

John P. Dawson
Director, Arizona Dept. of Water Resources

2/24/99
Date

Karen R. Hitt
Director, Arizona Dept. of Environmental Quality
DIRECTOR, WATER QUALITY DIVISION

12/14/98
Date

Michael J. Crable
Commissioner, Arizona State Land Dept.

8/17/98
Date

Jesse E. Thompson
Chairman, Board of Supervisors, Cochise County

11/2/98
Date

for [Signature]
Mayor, City of Sierra Vista

9/17/98
Date

Lyle R. Reddy
Mayor, City of Bisbee

8-18-98
Date

Leslie R. Corey
The Nature Conservancy

8/18/98
Date

Barbara J. Vargan
Town of Huachuca City

10-22-98
Date

State Director, Bureau of Land Management

Date



Commander, Fort Huachuca, U.S. Army

24 SEP 28

Date

Forest Supervisor, Coronado National Forest

Date

District Chief, U.S. Geological Survey

Date

Director, Arizona Dept. of Water Resources

Date

Director, Arizona Dept. of Environmental Quality

Date

Commissioner, Arizona State Land Dept.

Date

Chairman, Board of Supervisors, Cochise County

Date

Mayor, City of Sierra Vista

Date

Mayor, City of Bisbee

Date

The Nature Conservancy

Date

Town of Huachuca City

Date

SIERRA VISTA SUB-WATERSHED of SAN PEDRO RIVER
SAN PEDRO PARTNERSHIP

PROPOSED WATER CONSERVATION
POLICIES / PROJECTS
(selected as worthy of investigation)

IMMEDIATE STRATEGIES- It is recommended these activities be pursued immediately because there appears to be a consensus that our water use conflicts are serious enough to warrant implementing reasonable and prudent actions to conserve our water resources and to at least investigate the feasibility of the more costly solutions that might be implemented if the water conservation benefits are found to be significant compared to the cost. Before longer term strategies can be justified the results of implementing these strategies should be monitored and evaluated, and a more thorough understanding of the sub-watershed hydrology should be obtained.

- **Continue Water Conservation Efforts-**

- **Purpose:** Work as a community and with other governmental agencies to encourage water conservation policies and to encourage and promote water conservation practices by individual home owners, businesses and developers that will minimize water use for human endeavors within the watershed.
- **Actions:** Continue reviewing local ordinances through the City and County Planning and Zoning processes to promote reasonable water conservation practices in our building codes. Continue ongoing programs to educate the public and encourage water conservation. Pursue acquisition of private water supply companies by public agencies so water conservation incentives can be implemented.
- **Action Agency:** ADWR (Tucson), others

- **Integrate Urban Storm Water into Sewer System**

- **Purpose:** Increase influent by capturing urban storm water through an infrastructure system that connects with the sewer system. The storm water would increase the amount of reclaimed water that could be recharged.
- **Actions:** Perform survey of sewer lines and engineer the necessary infrastructure to integrate the urban storm water into the sewer system. Initial integration of storm water capture through construction of infrastructure would be dependent upon the capacity of the existing sewage treatment plant. Necessary infrastructure expenditures could be phased over time along with

upgrades to the capacity of the sewage treatment plant as the impervious surfaces increased with the growth of the urban area.

- **Action Agency:** Sierra Vista, FtH, Huachuca City
- **Establish Irrigation Non-expansion Area (INA)-**
 - **Purpose:** Eliminate high water uses with low economic value in portions of the San Pedro watershed that supply groundwater to critical sections of the river requiring perennial flow.
 - **Actions:** Request ADWR establish an INA for the Sierra Vista Sub-watershed to restrict new irrigation uses for crops. Then purchase any existing irrigation rights that use more than 1 acre-foot per acre per year.
 - **Action Agency:** ADWR (Phoenix), NRCD
- **Encourage Open Space Uses**
 - **Purpose:** Encourage open space / low water uses outside the urban areas, so the rural character of the San Pedro sub-watershed is protected, natural recharge is preserved and water use is minimized.
 - **Actions:** Retain low density land use zoning in the existing rural areas. Promote the purchase of conservation easements to encourage continuation of ranching and other low water uses. Encourage cattle grazing on public lands outside the SPRNCA to retain viable ranching operations. Promote funding to retain range land vegetation, to reduce erosion and to enhance natural recharge.
 - **Action Agency:** NRCD, TNC
- **Acquire Ephemeral Arroyos**
 - **Purpose:** Acquire the floodplain of the natural arroyos between the mountains and the river so they will not be developed and can be retained and improved as necessary to maximize recharge of water to the groundwater aquifer and to serve as linear parks / wildlife corridors through urbanizing areas.
 - **Actions:** Develop educational programs regarding the benefits of retaining these areas for humans and animals to share and for water recharge. Continue the policy of prohibiting development within the 100 year floodplain as a flood control measure and requiring dedication of those areas to the public when development of adjacent land occurs. Encourage the County to implement similar policies. Purchase fee title or easement rights to these areas where development is not expected to occur in the near future so a continuous corridor can be established.
 - **Action Agency:** NRCD, TNC

- **Eliminate Groundwater Pumping Near The San Pedro River-**
 - **Purpose:** Eliminate all pumping of groundwater within at least one mile of the San Pedro River floodplain aquifer so there is no direct pumping from the flood plain aquifer of the surface water needed by the river.
 - **Actions:** Exchange State Trust Lands within the Sierra Vista Sub-watershed for BLM lands outside the area. Use the exchanged lands to either trade for private lands near the river or to sell to produce revenue for the purpose of purchasing private lands or water usage rights near the river.
 - **Action Agency:** County, BLM, FtH
- **Sierra Vista Water Reclamation (effluent recharge) Project-**
 - **Purpose:** Recharge effluent between the San Pedro river and the pumping cone of depression under Sierra Vista to protect the river's groundwater supply from any adverse effects as a result of Sierra Vista or Ft Huachuca water use.
 - **Actions:** Phase I feasibility study and design is complete. Begin Phase II Construction of the required sewage treatment facilities, wetlands treatment and rapid infiltration basins. Require all new development to connect to a central sewer system so their effluent can be properly treated and recharged to first augment the river base flows where needed and then to conserve ground water resources.
 - **Action Agency:** Sierra Vista
- **Ft Huachuca Water Reclamation (effluent recharge) Project-**
 - **Purpose:** Convert existing effluent and storm water retention/evaporation ponds into rapid infiltration basins to improve recharge of that water into the pumping cone of depression or develop a distribution systems to reuse effluent to reduce groundwater pumping within the pumping cone of depression.
 - **Action:** Begin a Phase I feasibility study to assess the quality and quantity of water available. The feasibility study should include the option of reusing more effluent on golf courses and parks within the city to reduce groundwater withdrawals in lieu of recharging effluent to replace pumped groundwater. If feasible, design and construct any improvements to the sewage treatment system needed to produce effluent meeting recharge or reuse standards and any recharge basins or reuse delivery systems to implement the most sensible option.
 - **Action Agency:** FtH
- **Community Water Reclamation Projects-**
 - **Purpose:** Recharge effluent between the San Pedro river and/or its tributaries and the cone of depression caused by communities pumping groundwater for domestic or

other use to most effectively protect the river's groundwater supply from any adverse effects as a result of such groundwater use.

- **Actions:** Assist communities (incorporated municipalities such as Huachuca City and Bisbee or the County in unincorporated areas such as Naco) in securing funding for feasibility studies to determine the best reuse of their effluent. Require all new development in incorporated areas to connect to the central sewer system so their effluent can be properly treated and recharged to first augment the river and/or tributary base flows, where needed, and then to conserve ground water resources. Encourage County government to have similar requirements to connect to a central sewer system and recharge effluent for any developments with less than 1 unit per 2 acres zoning.
- **Action Agency:** County, Huachuca City, Bisbee
- **Eliminate Water Supply Exportation From Critical Areas-**
 - **Purpose:** Eliminate the exportation of water from the Sierra Vista sub-watershed, where supply is critical to the SPRNCA by finding alternative sources of water for communities that are located outside of the watershed or down stream of the perennial portion of the river.
 - **Action:** Conduct a feasibility study to include the cost / benefit of moving the water supply wells serving Bisbee to the Sulfur Springs watershed where most of the community is located. If moving the water supply source is feasible and cost effective, secure funding to assist Arizona Water Co. with the cost of relocating their wells and modifying the water supply lines to accomplish the change. Explore the feasibility of relocating the water supply source for Tombstone to the Tombstone portion of the watershed. If feasible, secure funding to develop a new source of water so the existing source in the Huachuca mountains can be restored to supplying water to the San Pedro River.
 - **Action Agency:** County, Bisbee, Tombstone
- **Flood Water Detention Basin Recharge Project-**
 - **Purpose:** Improve infiltration time of low flows to reduce evaporation and slow peak flood flows to increase recharge through the use of detention basins so total storm water recharge from the watershed into the groundwater aquifer improves.
 - **Action:** Measure the recharge value of the existing detention basins along Buffalo Soldier Trail and suggest methods of construction or operation that will improve recharge. If significant recharge can be cost effectively achieved, construct more detention basins.
 - **Action Agency:** Sierra Vista, County, FtH
- **Pilot Off-line Urban Runoff Recharge Basin (Hatfield Basin on Ft Huachuca)-**

- **Purpose:** Capture storm water runoff resulting from urban development on Ft Huachuca move it out of the drainage channel to an off-line infiltration basin to recharge the groundwater aquifer.
- **Action:** Feasibility study is complete. Complete design and construction of a pilot project. Monitor the results of the recharge project. If significant recharge can be cost effectively achieved, construct more projects.
- **Action Agency:** Sierra Vista, County, FtH
- **Pilot In-Channel Recharge / Erosion Control Project-**
 - **Purpose:** Reduce channel slopes in Graveyard Gulch near the San Pedro River by installing check dams to slow in-channel flows, improve channel infiltration and reverse erosion trends, which should result in restoration of historic groundwater recharge and riparian characteristics within the arroyo.
 - **Actions:** Complete design and construction of check dams. Monitor results of the project If significant recharge can be cost effectively achieved,, construct similar projects in other arroyos.
 - **Action Agency:** Sierra Vista, County, FtH
- **Restore Gravel Pit Retention Basin-**
 - **Purpose:** Remove silt from existing gravel pit to restore retention basin configuration and improve recharge of storm water to the groundwater aquifer.
 - **Actions:** Remove silt. Monitor the results of the project. If results are significant, establish a periodic maintenance schedule to keep the basin functioning and consider other locations where similar retention basins might be constructed.
 - **Action Agency:** Sierra Vista, County, FtH
- **Investigate SPRNCA Water Needs-**
 - **Purpose:** Determine the proper vegetative mix to optimize the biodiversity of the most desirable (threatened) species that depend on the San Pedro Riparian National Conservation Area (SPRNCA) and quantify the minimum amount and type of water necessary to sustain that mix so that supply can be assured during critical periods.
 - **Actions:** Identify the most desirable species we are trying to protect and the habitat characteristics needed to support those species. Compare current habitat characteristics with desired habitat. Determine the minimum amount of water needed to support the desired habitat compared to the amount currently available. Manage the vegetation and water to provide the desired habitat while conserving water resources.
 - **Action Agency:** BLM

- **Quantify Mountain Front Recharge-**

- **Purpose:** Determine through measurement and analysis the amount of groundwater recharge naturally occurring in our ephemeral arroyos to an accuracy sufficient to determine the benefit versus cost of storm water recharge projects and the amount of runoff from the Sierra Vista sub-watershed mountain ranges that enters the ephemeral arroyo system and is ultimately recharged to the ground water system.
- **Actions:** Install instrumentation to determine the amount of recharge to the groundwater system for a variety of flow conditions in a representative unimproved arroyo and the amount of runoff from the mountains actually reaching the arroyo after various rainfall events. Extrapolate the information gathered to determine the amount of mountain front recharge actually occurring in the entire Sierra Vista Sub-watershed under various rainfall conditions.
- **Action Agency:** USGS ?

- **Investigate the Decline in Sub-watershed Runoff**

- **Purpose:** Determine the reason total runoff within the sub-watershed is declining with particular emphasis on the effect changes in vegetative cover within the watershed may have had on ground water recharge and what might be done to reverse the trends.
- **Actions:** Analyze the water needs of grasslands, mesquites and desert shrubs and the effect each type of vegetative cover may have on groundwater recharge. Document the changes that have occurred in the last 60 years in vegetative cover within the sub-watershed and determine the long term effects these changes may have had on groundwater recharge. If significant changes are determined, identify how vegetation could be better managed to improve groundwater recharge and to restore historic habitat.
- **Action Agency:** USGS

- **Update and Expand Groundwater Computer Modeling Tools-**

- **Purpose:** Update the Arizona Department of Water Resources (ADWR) Groundwater Computer Model to reflect the most current data available, particularly the new information on uses of groundwater in Mexico, so policy makers have the most current modeling tools available to better understand the past and future causes of water use conflicts within the Sierra Vista Sub-watershed and to test various strategies to minimize future conflicts.
- **Actions:** Acquire and validate current information on water use in Mexico and the United States, on basin geology, on evapotranspiration and on other model inputs. Secure funding to have the ADWR model updated and calibrated with the most current information. Transfer modeling information to an easier to use PC GIS based model. Develop various scenarios for the future use of groundwater resources

and test each scenario assuming various solutions as soon as adequate information is developed regarding the effectiveness of each potential solutions.

- **Action Agency:** ADWR (Phoenix), Sierra Vista
- **Reduce Groundwater use in Mexico-**
 - **Purpose:** Eliminate high water uses with low economic value in portions of the San Pedro watershed that supply groundwater to critical sections of the river requiring perennial flow and encourage open space / low water use land uses.
 - **Actions:** This strategy has the same purpose as the suggestion we eliminate crop irrigation and encourage ranching in the United States portion of the watershed. It is beyond the scope of actions local or state government can take other than to encourage federal agencies to pursue it on an international level. The complexity of such a strategy probably requires that it be placed in the category of a longer term strategy even though it would probably be of great benefit if it could be treated as an immediate action.

LONGER TERM STRATEGIES- It is recommended that these strategies not be considered unless and until we have a lot more information on the scope of the "water use conflict problem" and evidence that the recommended strategies listed above are either not working or will not adequately address the "conflict" for the foreseeable future. In fact, many of the strategies listed above will be found to fall within this longer term category because the cost will exceed the benefit by more than is considered "reasonable", given the scope of the

“problem” in the near term. Those too should be revisited occasionally along with the following list of long term strategies.

These strategies are preliminary in nature and are only intended to be a list for consideration. The actual decision to implement one or more of the listed strategies will require a thorough examination of the “problem” that needs to be addressed at the time and the ability of each strategy to resolve the problem in a cost effective way.

- **Augment River Flows with Effluent-**

- **Description:** Use treated sewage effluent to augment river base flows during periods when augmentation is needed. Effluent could either be recharged directly into the floodplain aquifer to augment or replace ground water discharge or stored and used directly as river base flow for discharge during periods when augmentation is needed. This strategy is basically the same as the effluent recharge strategy suggested above only the point of recharge, or use, is moved closer to the river so the benefits are more directly received. The treatment facilities would already be in place and studies show a significant increase in benefit to the river when recharge is moved closer. The point of recharge or reuse could also be moved upstream if necessary.

- **Augment River Flows with Storm Water-**

- **Description:** Dam the river south of the riparian area to store flood flows for purposes of recharging the floodplain aquifer and for discharge to augment river base flows during periods when augmentation is needed. If augmentation is not necessary, an alternative to a single large dam to store water would be a series of smaller (beaver type) dams to simply recharge the floodplain aquifer.

- **Relocate Source of Water Supply**

- **Description:** If the Sierra Vista Sub-watershed is not able to generate a sufficient water supply to meet its cultural and natural needs through storm water recharge then it must look to other sources of supply to meet those needs or change/reduce the need. There have been several suggestions for a new source of supply that could be investigated when, and if, necessary. Water might be obtained from the Central Arizona Project (CAP), from the Sulfur Springs Watershed, or from the Benson Sub-watershed. All three sources would be expensive and politically difficult. A reconnaissance level study was done by BoR on bringing in CAP water for use as a local water supply. The study should be updated and should explore the option of simply bringing in the amount needed to keep the river operating properly and then letting the human use rely on the estimated 19,000 AF of recharge that naturally occurs, any additional storm water recharge that might be generated and/or groundwater in storage.

- **Increase Supply of Rainfall**

- **Description:** If the Sierra Vista Sub-watershed is not able to generate a sufficient water supply to meet its cultural and natural needs through storm water recharge, but storm water recharge proves to be an effective strategy, then increasing rainfall may be a viable option. Cloud seeding has been investigated in other dry areas and found to be effective for increasing rainfall. The environmental effects of increased rainfall would need to be thoroughly investigated. Cloud seeding could be used to increase the winter snow pack and mountain front recharge or to increase the up stream rainfall and normal flood plain recharge. There has been concern expressed about the potential for adverse effects on the SPRNCA vegetation from reducing peak flood flows as a result of increasing storm water harvesting. Cloud seeding may be a viable strategy to increase natural river flooding in an effort to offset those potential effects.

Appendix 2: Summary of Biological Opinion

21-98-F-266

SUMMARY: PLAN-LEVEL BIOLOGICAL OPINION FOR LAND USE, MILITARY OPERATIONS, AND TRAINING RANGE UTILIZATION AT FORT HUACHUCA

Date of Opinion: October 27, 1999

Action Agency: US Army, Fort Huachuca, Arizona

Project: Land use, ongoing and planned training activities, construction activities, administrative and support actions, recreation, fire management, and other activities proposed by the Army at Fort Huachuca and adjacent areas for a 10-year period from the date of this opinion. The Fort and the Service developed a Memorandum of Agreement in which the Fort committed to water resources planning that will maintain and protect populations of listed species and their habitats, including those on the San Pedro River. The MOA also includes comprehensive mitigation measures for listed species that occur on post.

Listed/Proposed Species and Critical Habitat Affected: Huachuca water umbel, *Lilaeopsis schaffneriana* var. *recurva* (with critical habitat); southwestern willow flycatcher, *Empidonax traillii extimus*, (with critical habitat); the Mexican spotted owl, *Strix occidentalis lucida*; lesser long-nosed bat, *Leptonycteris curasoae yerbabuenae*; and Sonora tiger salamander, *Ambystoma tigrinum stebbinsi*.

Biological Opinion: The Service determined that the proposed action is not likely to jeopardize the continued existence of the listed species considered, and is not likely to result in adverse modification and destruction of critical habitat designated for the flycatcher and the water umbel. Although this is a "plan-level" biological opinion, in that it addresses a range of programs and projects, all aspects of the Army's activities at Fort Huachuca discussed with specificity are covered herein to the project level for 10 years from the date of the final opinion. The opinion also includes concurrences that the proposed action may affect but is not likely to adversely affect the Canelo Hills ladies' tresses, *Spiranthes delitescens*, spikedace, *Meda fulgida*; and loach minnow, *Tiaroga cobitis*.

Incidental Take Statement:

Level of take anticipated: One or more forms of take is anticipated for each of the animal species with the exception of the southwestern willow flycatcher.

Reasonable and Prudent Measures, Terms and Conditions: Draft reasonable and prudent measures and terms and conditions were adopted by the Fort as mitigation measures to their proposed action. Thus, in the incidental take statements, the Service only requires that these measures be implemented. The mitigation measures include a variety of actions to reduce incidental take, such as modifying actions that result in take of individual animals, education of project personnel, preconstruction surveys, and monitoring of take and habitat loss.

Conservation Recommendations: Conservation measures are recommended for all listed species. Suggested measures include implementation of recovery tasks, clarification of a species range or distribution, further studies into the effects of military activities, and other related matters.

Appendix 3: August 28, 1998, letter from Nick Melcher, USGS, Water Resources Division, to Jim Rorabaugh, US Fish and Wildlife Service, Phoenix, AZ



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Water Resources Division
Arizona District
520 North Park Avenue, Suite 221
Tucson, Arizona 85719

August 28, 1998

Mr. Jim Rorabaugh
U.S. Fish and Wildlife Service
Arizona Ecological Services Field Office
2321 W. Royal Palm Road, Suite 103
Phoenix, AZ 85021-4951

Subject: Review of the effects analysis within the Draft Biological Opinion on the Huachuca Water Umbel of the San Pedro River Basin, Arizona

Dear Jim,

We have reviewed a section of the subject report, as requested in your email letter of July 16, 1998. This section focuses on the hydrology of the Upper San Pedro basin, and the effects of groundwater pumping on the river. We found in general that the author(s) did an excellent job of reviewing what has been written, both published and unpublished, about the San Pedro and paraphrasing the findings. Our major comments relate to the conclusions drawn from the information presented.

The "proposed action" is not described in the section of the report we were asked to review, but in a subsequent phone call we learned that the proposed action is essentially the current situation or the continued operation of Fort Huachuca. As we understand the summary section of this report, the Service finds that the current situation or the on-going operation of Fort Huachuca jeopardizes the existence of the Huachuca Water Umbel, an endangered plant.

The gravity of this finding would seem to require a high level of certainty about how the hydrologic system functions and the consequences of the actions proposed upon the Water Umbel. We would point out that a great deal of uncertainty exists for some components of the hydrologic budget and the manifestation of effects. Rather than a detailed point-counter point discussion over the findings presented by the various authors cited in your draft document, this review provides comment on the certainty of our scientific understanding of the hydrology of the San Pedro basin, and conclusions that can be reasonably drawn.

Certain principles of groundwater hydraulics are known with confidence. For example, withdrawal of ground-water from storage will cause water levels to decline continuously until additional ground-water recharge is induced, ground-water flow to the river is reduced, or the aquifer is depleted of water and pumping ceases. The assumption for the San Pedro is that pumping will result in a reduction of ground-water flow to the River.

The major areas where uncertainty is high are as follows:

1315

315

Climate Variability

Climate variability is often cited by investigators as a possible causal factor for the diminishment of summer baseflows in the San Pedro River. Yet, a thorough analysis of the precipitation and streamflow record has not been done and reported in a refereed scientific report. Important aspects of the annual precipitation and streamflow patterns have not been examined, such as changes in seasonal distribution of precipitation, high elevation versus valley bottom precipitation, trends in total annual runoff and so on. The evidence presented thus far regarding climate does not satisfactorily exclude climate variability as a causal factor in the diminishment of low-flow in the San Pedro.

Hydrologic Budget Components

It is important to remember that the hydrologic budget is comprised of only two components that are actually measured: streamflow and ground-water pumpage. These are known with acceptable confidence. The long-term average runoff from the basin as measured at Charleston is about 40,470 acre-feet/ year but only 7,930 in WY97. All other components are estimates which may have large errors associated with them. For example, ground-water recharge cannot be measured directly but is estimated to be about 19,000 ac-ft./yr. Recharge then is only about 2% of the total volume of water (~800,000 ac-ft./yr.) that enters the basin from precipitation¹. Ground-water pumpage is by definition equal to the annual deficit of about 7,000 ac-ft./yr., however, this deficit is relatively small compared to the other budget components for the basin.

Site Specific Prediction of Effects

The draft biological opinion presents a discussion that is specific to the existing occurrences of the Huachuca Water Umbel, some of which but not all, are along the San Pedro. To support a finding of jeopardy, the prediction of effects from pumping, the assumed causal agent, must be sufficiently accurate to apply to a specific location at some distance from the pumping centers. This is a standard that our current level of understanding cannot meet. For example, the San Pedro above Charleston may not be as vulnerable to pumping from Huachuca and Sierra Vista as the Babocomari River and the San Pedro downstream from Charleston. Unfortunately, hydrologic conditions in these areas have not been monitored on a routine basis using stream gages or by repeated measurements of water levels in wells. It is possible that a portion of the cone of depression, primarily resulting from wells that supply the Sierra Vista area, has intercepted ground-water flow to the San Pedro River above Charleston, but the effect would be a small portion of the total withdrawn by Fort Huachuca and Sierra Vista. Effects from these wells on river flow above Charleston would be detected by a clear trend in reduced winter base flow at the Charleston gage that is not related to climate, evapotranspiration, or up-gradient ground-water withdrawals near the river; or a change in ground-water gradients in the regional aquifer near the river. The streamflow record to date does not show a clear trend in winter baseflow.

Consideration of Mexico Pumpage

The text presents a good summary of current knowledge of the hydrologic system and ground-water use in the Sierra Vista Sub-Watershed. The only element that is missing is a discussion on water use in Mexico that reflects the information presented in the recent draft of the

1. assuming 1,200 mi² above the San Pedro at Charleston gage and an average basin-wide precipitation of 12 in.

Commission on Environmental Cooperation (CEC) report. Mexican water use is apparently much greater than previously thought and could have significant effects on flow in the San Pedro River as it flows into the United States (July 29, 1998 Casadevall letter to DOI-DAS for Policy and International Affairs). The CEC report has an estimate of 8,000 acres of irrigated lands near the river in Mexico. Annual ground-water use for irrigation of this land could range from 2 to 4 ac-ft./acre or 16,000 to 32,000 ac-ft./yr. In addition, ground-water use by the Cananea mine from the San Pedro Basin is about 10,000 ac-ft./yr. or more. Use by the mine would not be expected to have as significant an impact on flow of the San Pedro River in the US as the use for irrigation because the withdrawals are further from the border and the river than the irrigation withdrawals. Water use in Mexico is far in excess of use in the United States. This new information should be considered in any analysis of the effects of ground-water use and flow of the San Pedro River.

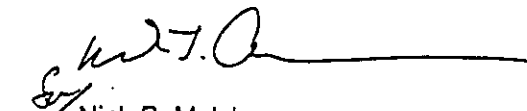
Other Effects

The draft opinion cites an increased risk of wildfire as the greatest non-pumping risk to the Water Umbel because of the risk of operationally ignited wildfires from Ft. Huachuca. However, no data are presented to support this claim. Similarly, no data are presented that wildfires, even if ignited more often by human activities, increase the mortality of the Water Umbel. The vulnerability of the Huachuca Water Umbel to wildfire seems speculative.

The existing Water Umbel populations, such as the one near Tombstone, include ephemeral streams. An explanation is not provided for this apparent contradiction in which the above Charleston (on the San Pedro) occurrences of the Water Umbel are assumed to be in great peril because of reduced base flows. What evidence exists that mortality for the Water Umbel increases with declining base flows, or the conversion of a river from perennial to ephemeral?

In conclusion, scientific uncertainty exists in varying degrees surrounding the hydrology of the San Pedro River basin. Some cause and effect relations are not known and will be difficult to prove without further study. If the Service can base its jeopardy opinion on the concept that pumping will at some point in time and space, reduce the flow of the River, and that this reduction results in mortality of the Water Umbel, then the Service would have a valid argument. If on the other hand, the Service bases its finding on the premise that pumping has already reduced flow of the River, or at a particular place, this will be difficult to prove and may become a technical quagmire.

Sincerely yours,


Nick B. Melcher
District Chief

Appendix 4: Supporting information, from Fort Huachuca, for a calculation of water use in the Sierra Vista subwatershed attributable to Fort Huachuca and included as indirect, interrelated, and interrelated effects of the proposed action.

Population data published by Fort Huachuca comes from a number of separate databases. These data bases, some of which are federal government systems and others are managed by government contractors, do not cross reference their data. Several years ago, Fort Huachuca became aware that the method of population reporting from these data bases led to double counting of some individuals who may be subject to several reportable categories. An example of this would be a military family member who lives on Fort Huachuca who is also a government civilian or contract worker on the fort. This person would be counted twice initially, and an additional 1.3 family members would be attributed to them in the off-post population. This is due to the assumption that all government civilians and contractors live off the installation, and using the 1990 census average household size of 2.3 in Sierra Vista. The individual would then account for 3.3 non-existent people in the local community using these methods and assumptions.

The overcounting becomes even more complex because many government civilians and contractors are also military retirees. If the family member in the above example were also a retired military member, he or she would count as another 2.3 people using the assumptions that they live off the fort and have an average household size of 2.3 people. This would count the initial individual for a total of 5.6 people, 4.6 of whom do not exist. Similar types of overcounting may occur when spouses living off the fort both work on the fort. They would then be counted as two separate households for a total of 4.6 people rather than 2.3 people.

Employees: In an effort to better define the fort population, and that which may be related to employment on the fort, Fort Huachuca conducted a survey to gather and statistically analyze data (SAIC, 1999). The survey findings revealed these double counts:

- 21.7% of military personnel are also household members of other employees working at the Fort.
- 18.8% of government civilian personnel have other household members who work at the Fort.
- 21.2% of contractor employee personnel have other household members who work at the Fort.
- 3.2 percent of the employees and their families do not live in the Sierra Vista subwatershed

- 10.7% of government civilians working on the fort live on the fort as military family members.
- 6.6% of government civilians working on the fort live off the fort as military family members
- 12.5% of contractors working on the fort live on the fort as military family members.
- 4.9% of employees have two jobs on the fort.

Retirees: An estimated 18.8% of current government civilian employees are also retired military living in the Sierra Vista area. The survey also revealed that 40.7%, of government contract employees working at Fort Huachuca are military retirees (SAIC 1999). Another 13% of non-military employees at Fort Huachuca have retirees as family members. These double counts account for approximately half of the military retirees attributed to the Sierra Vista subwatershed area.

Fort Huachuca has calculated the acre-feet of water attributable to the Fort's presence by starting with the amount of water pumped on-post (2,355 acre feet/year) and then adding water pumped off-post to support military and civilian employees and their dependents, contractors and their dependents, and military retirees and survivors (Appendix 4). This analysis uses factors developed by a survey conducted on Fort Huachuca by SAIC (1999) as applied to population data from the annual impact report (1998). The analysis corrects for double or triple counting of individuals who appear in different non-cross referenced data bases in different categories (i.e. some retirees are also contractors, some contractors are also dependents of military personnel, etc.). From the Table in Appendix 4, off-post water use attributable to Fort Huachuca is 2,560 acre-feet/year. This, added to on-post pumpage, totals 4,915 acre-feet/year (not adjusted for recharge).

This water amount may not reflect the complete effect that Fort Huachuca has on the water use in the subwatershed. For example, some businesses and the employees they support probably would not be in the Sierra Vista area but for the Fort's presence, even though those businesses do not deal directly with Fort Huachuca. To estimate this impact, Fort Huachuca (1998) used a standardized Economic Impact Forecasting System (EIFS) model developed by the U.S. Army Corps of Engineers which draws on historical economic data to determine indirect economic impact. The economic multiplier of 1.684 was determined by the model and when applied to the Fort's 10,362 person work force and estimated that Fort Huachuca supports 17,540 job equivalents in Cochise County. The 17,540 job equivalents include the employment at the military installation (Robinson, et.al. 1984; R.D. Webster, personal communication). After subtracting the 10362 employees at Fort Huachuca, this leaves another 7178 job equivalents related to the fort within Cochise County. After correcting for employment at the fort, approximately 41% of Cochise County employment is within the Sierra Vista subwatershed, and the majority of non-government jobs in the county fall into the lower-paying service and trade (retail) categories (ADOC 1997). That would indicate that approximately 2943 of those 7178 job equivalents are within the subwatershed.

Approximately 5288 off-post households are related to fort workers (Appendix 4). The 39,405 residents of Sierra Vista (ADOC, 1997) which include the fort's resident population, comprise 17,133 households using the 2.3 person average household size. We can extrapolate that 5288/17133, or 31% of these job equivalents are held within a household already counted in the fort's off-post population, and another unknown number are held by family members living on the fort. Fort Huachuca maintains approximately 1950 family housing units, which places an upper limit on the number of households on the fort. An estimate of 1950/17,133, or 11% is an estimate of the number of job equivalents off-post that are held by family members living on Fort Huachuca. Military retirees (1779) and their survivors (336) not already employed on Fort Huachuca are another source of individuals to hold some of these job equivalents. Due to the potential infirmities of old age which may exclude members of this group from working, approximately half of the 2115 military retirees and their survivors may hold some of these job equivalents. An estimate of 1058/39,405, or 3% is an estimate of the number of job

equivalents off-post that are held by military retirees and their survivors. This totals 45% of the 2943 job equivalents in the subwatershed leaving 1619 job equivalents. Because of the lower-paying nature of non-government jobs in the Sierra Vista area, a job equivalent may be made up of several part-time jobs which may be held within the same household. Therefore, there is no accurate way to determine how many households are represented by these job equivalents, or whether non-working dependents may be associated with these job equivalents. A conservative estimate would be that one third of these job equivalents, or 534, may represent households that have not otherwise been counted within the watershed. Using the average household size of 2.3 from the 1990 census, this would result in an estimate of 1228 additional people living in the subwatershed as a result of the fort's presence.

Water usage per capita is the next figure that must be estimated. ASL (1998) estimated that each person in the subwatershed uses approximately 164 gallons of water per day. In a letter to the editor in the September 5, 1999, edition of the Sierra Vista Herald, City Council Member Casey Jones presented data indicating per capita use for the three largest water companies that operate in Sierra Vista is 120-126 gallons per day. Fort Huachuca uses the figure of 150 gallons per day for per capita use on post (Appendix 4). If we use the middle figure (150), and assume 1228 additional people live in the subwatershed as a result of Fort Huachuca, then roughly $1228 \times (150 \times 365) / 325,821 = 206$ acre-feet per year are attributable to this group of people. This brings the total attributable to the Fort's presence to an estimated 2355 af/yr for on post, 2560 for the off post use by employees and their families, and 206 for indirect employment and their families for a total of 5121 acre feet.

Taking the calculations above with those from Appendix 4, roughly 5121 acre-feet of groundwater is attributable to the Fort's presence (direct, indirect, and interrelated/interdependent effects). This represents approximately 54% percent of all groundwater pumping in the subwatershed ($5121 / 9,400$: 9,400 is the year 2000 estimate of total pumping from the CEC San Pedro Expert Study Team 1999). This 54% percent, which does not include the fort's proven annual recharge of over 500 acre feet, would also roughly represent the Fort's contribution to the deficit in the subwatershed's water budget. The net water use for the fort, including recharge, falls just under 50% of the year 2000 projection from the CEC report. This estimate should be revised as new information is developed.

Additional References:

Arizona Department of Commerce (ADOC). 1997. Profile: Cochise County, Arizona. Published by the State of Arizona, Phoenix, AZ.

D.P. Robinson, J.W. Hamilton, R.D. Webster, M.J. Olsen. 1984. Economic Impact Forecast System (EIFS) II: User's Manual, Updated Edition. US Army Corps of Engineers Construction Engineering Research Laboratory Technical Report N-69 (Revised). May 1994

Ron D. Webster, Army Environmental Policy Institute. Co-developer of EIFS, the Economic Impact Forecast System that created the economic multiplier used. He can be reached at (404)880-6707.

1998 POPULATION CORRECTION AND OFF POST WATERUSE WORKSHEET

Category	# of people	Correction factor	Denominator	subtotal	Corrected value	Corrected subtotal	Comments
Military OP	3172					3172*	Military personnel who live on post
Military family members (FM) on post	4431					4431*	family members (FM) who live on post
Military off	2249					2249**	Military personnel who live off post
FM off post	3698					3698	family members who live off post
Gov't Civilians (GC)	2442	-10.5% GC -6.6% off	2442 2249	-256 -148	2186 2038 =GC off post	1857**	4.9 percent of all employees on post have a second job on post 10.5% of GC live as FM on post 6.6 % of military off post with a FM who is also a GC 4.9% Second Job adjustment -3.2% who live outside the watershed and not on post
GC FM		-12% -8.5% -12.5%	2038 1399 672	-245 -119 -84 =448	1857-448= 1409	2508	12.0%of GC off post have another GC in their Household 8.5%of C off post have a GC in their Household 12.5%of other employees off post have a GC in their Household avg number of FM per non-mil employee
Contractors (C) and other support (S)	2499	-12.7% COP -25.0% S	1603 896	-204 -224	1399 off post 672 off post =2071 off post	1887**	12.7% of C live as FM on post 25% of other Support live as FM on post

		-4.9%	2499	-122	2071-122= 1949 off post -62 = 1887		4.9% Second Job adjustment
		-3.2%	1949	-62 =612			-3.2% who live outside the watershed and not on post
C FM		-6.8%	1399	-95	1887-357= 1530	2723	GC with contractors as FM C with other C as FM S with other C or S as FM
		-12.7%	1399	-178			
		-12.5%	672	-84 -357			
		1.78			1530 x 1.78= 2723		Avg # of FM per non-mil employee
Mil Retirees	3440	18.8%	2442	-459	3440-1661= 1779		GC employees
		40.7%	1603	-652			C employees
		14%	2442	-342			GC Household members
		13%	1603	-208 =1661			C Household members
Survivors***	336					336	
total						24640	
off post total						17037	
Off-post FTE		1.0	11044		11044	15239	* 100% of water use is on FH
waterusers		0.7	5993		4195		** 30% of water use is on FH
Water use		0.168 af/yr			15140 FTE	2560 af/yr	off post water use

*people whose water use is assumed to be 100% on post because they live on post

**people who are assumed to consume 70% of their water off-post. They live off post and work on post.

Retirees and family members of employees who live off the fort are assumed to have 100% of their water use off post.

***survey did not ask questions re: this status

FM= Family Members

GC= Government Civilian

C= Contractors

S= Other support (usually lumped in with contractors, but for some values separate. This group includes school teachers, PX employees, Credit Union employees, etc)

FTE= full time equivalent. This measure converts 70% water consumer population to 100% consumer equivalents so that a total can be estimated.

af/yr=acre feet per year. An acre foot is 325,821 gallons. The 0.168 af/yr is based on 150 gallons per day average water use per person.